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ABSTRACT

This curriculum guide on electrical occupations is designed to provide eleventh and twelfth grade teachers with the educational specifications for specific knowledge and skills that will qualify students for entry-level employment in five electrical occupational areas: inside electrician, outside electrician, electronics assembler, electrical appliance repair, and electronic technician. The guide is divided into four sections. The first one, an introduction, includes educational goals, definitions of terms, and provisions for approval of secondary vocational programs. The second section presents a world-of-work chart showing a career, occupation, and instructional analysis followed by a list of common skill requirements for each of the five occupational areas. Section 3 discusses goal-based planning and the main objective for the electrical cluster, individualized instruction, and suggested allied supporting courses to be included in the electrical cluster curriculum. In the last section, comprising the major portion of the guide, content is divided into five subsections, each covering one of the following skill areas in the electrical career education process: technical communications; testing and measuring; assembly, maintenance, and repair; electrical/electronic theory and math; and personal development and leadership. Each subsection includes the following correlated components: a course goal, student competencies (from fifteen to fifty-seven), performance indicators (from one to ten), and suggested learning activities. This last section concludes with a brief discussion of student assessment. Listings of audiovisual materials, references, and sources are appended. (EM)

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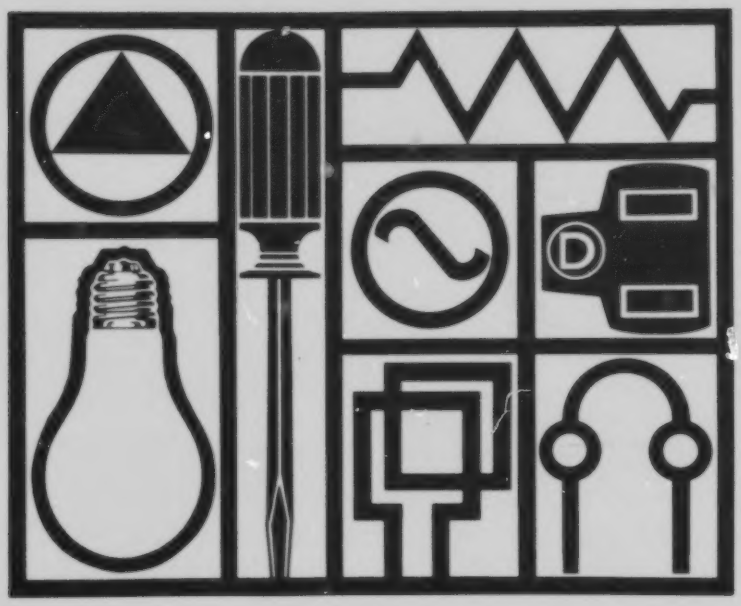

CURRICULUM GUIDE FOR ELECTRICAL OCCUPATIONS

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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1977

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PREFACE

In Oregon we can be proud of our progress in career and vocational education because it is the product of a decade-long effort and has received national recognition. The Oregon Department of Education offers this *Curriculum Guide for Electrical Occupations* hoping that it will provide useful information and serve as a catalyst in stimulating ideas for teaching electrical occupations.

The design of educational programs should recognize the several roles our students assume as individuals, learners, citizens, consumers, family members and producers. While focusing specifically on the role of producer, career education helps prepare students for all six life roles.

Since we are training young people for occupations with constantly changing requirements and for occupations yet to be created, we are faced with challenges as well as responsibilities. We need to work together and share good ideas. The Oregon Department of Education welcomes your comments.

Verne A. Duncan
State Superintendent of
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Industry and education worked together to develop this guide. Industrial representatives, special consultants, secondary school administrators and teachers participated in analysis studies, committee work sessions and individual reviews of all phases of its development.

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INTRODUCTION

OVERVIEW

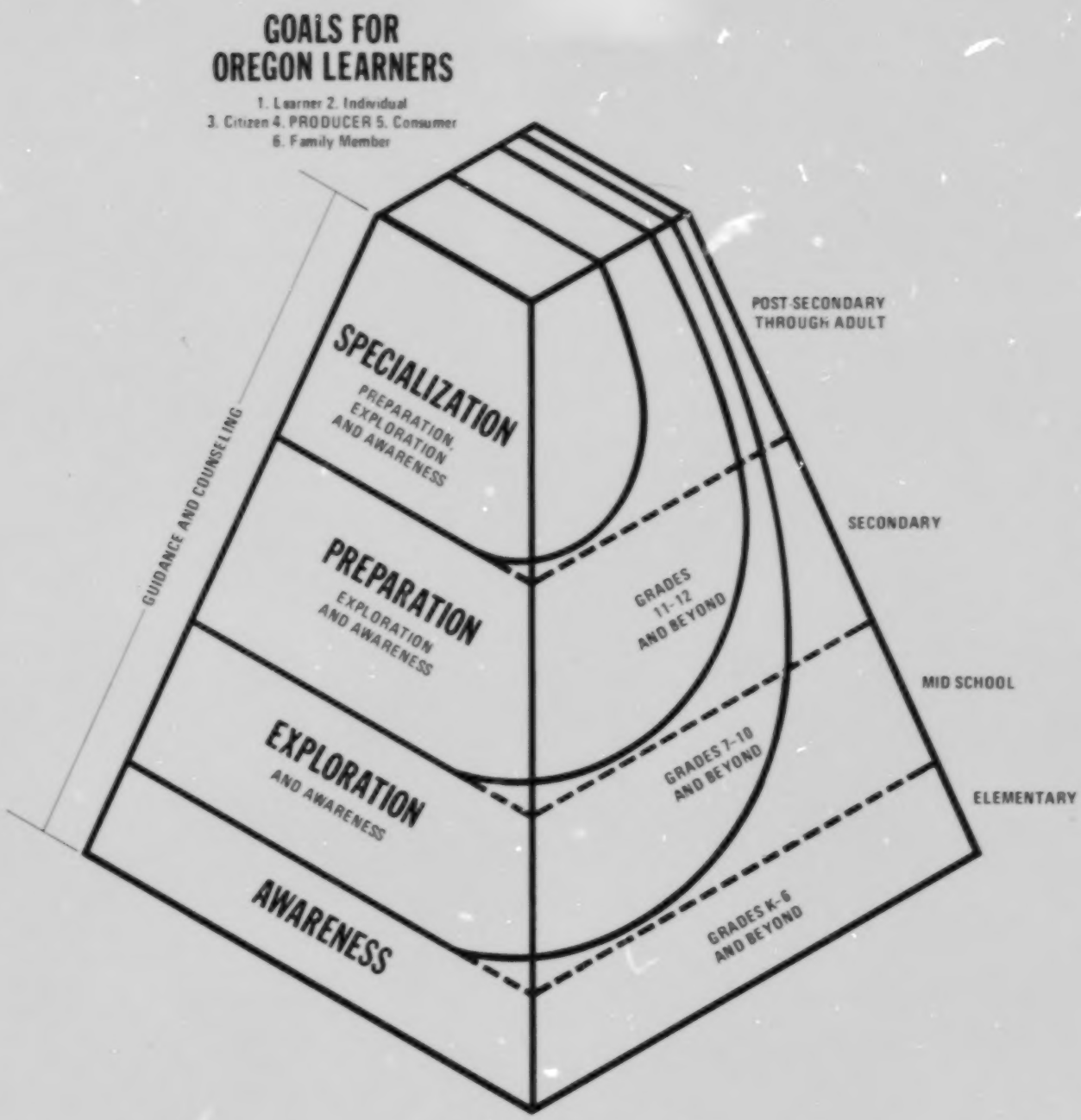
This guide is divided into five sections. The first one introduces vocational and career education in general and electrical occupation education in particular. It provides definitions of commonly used terms and guidelines for establishing acceptable secondary vocational programs. The text then focuses on a small but representative sample of electrical occupations. These are analyzed in terms of labor market trends and common skill requirements, from the student's point of view as well as the teacher's.

The second section of this guide begins by discussing the electrical cluster in terms of goal-based planning and then the cluster's main objective. After emphasizing the need for individualized instruction, the section offers suggestions for an electrical occupation cluster curriculum. After providing guidelines for establishing a high school cluster program, the text gives ideas for both core and elective courses.

The third section offers competencies and performance indicators for five phases of the career education process: technical communications, testing and measuring, assembly, maintenance and repair, electrical/electronic theory and math, personal development and leadership.

The fourth section discusses the need for assessment and suggests a number of criteria by which it may be carried out.

The appendices comprise the fifth section. See the table of contents for a complete listing of material included.



CAREER AND VOCATIONAL EDUCATION
IN OREGON

DEFINITIONS OF TERMS

Behavioral Objective. Is basically a performance indicator only with a criterion added (how well the student must do). Example: Given a list of ten colors and types of clothing, the student will identify a minimum of five each which are considered most safe for pedestrian use in various kinds of weather and illumination.

Career Awareness. Education which provides career growth opportunities as they relate to the six life roles, which develops an understanding of the world of work, which fosters a wholesome attitude toward self, work and society and which develops decision-making skills needed to make appropriate decisions for future career exploration. Other levels of instruction include exploration, preparation and specialization. Guidance and counseling are provided at each level.

Career Education. That education which links learning activities with jobs along the entire range of skills from the subtechnical ones to the professional skills. It is an integral part of the total educational program.

Career Analysis. A process of (a) grouping related jobs into families of occupations, (b) identifying key occupations, (c) analyzing job descriptions, (d) identifying performance requirements in the key occupations.

Cluster Curriculum. A curriculum which is based on related jobs grouped into a family of occupations and which emphasizes competencies derived from common tasks.

Competency. A demonstrated ability to perform a function representative of a group of similar tasks. Usually contains a performance verb and is more specific than a goal. Example: Distinguish between safe and unsafe apparel for pedestrian travel.

Concept. A major emphasis area identified for purposes of more effectively organizing curricula development efforts. Example: Building Construction Techniques.

Dictionary of Occupational Titles (D.O.T.). A two-volume publication of the U.S. Department of Labor. One volume contains the titles and definitions of 35,550 occupations in the U.S. The other volume groups the jobs by occupational, industrial or worker characteristics to help the user see relationships among occupations and to classify the abilities, vocational experiences and potential of workers.

Exploration. Provide students with opportunities to better understand themselves and the knowledge, skills, technical requirements, working conditions and political and social realities of each of the career fields that interest them.

Goal. A broad statements of instructional intent. May use such words as understand, know, appreciate, etc. Example: Students will be able to function as responsible citizens when participating in traffic as pedestrians.

Graduation Requirements. The State Board of Education adopted new minimum requirements for graduation in September 1972. In career development, each student should demonstrate competencies in the following areas: 1. good work habits, 2. a positive attitude toward work, 3. an ability to maintain good interpersonal relationships, 4. the ability to make appropriate career decisions, and 5. the ability to demonstrate the competencies required to function effectively in a chosen career.

Industrial Education. A general term applying to industrial related education, including Industrial Arts, Vocational Industrial (Trade and Industrial), and Technical Education.

Instructional Analysis. A process of (a) grouping knowledge and skills, (b) identifying expected student behaviors, (c) organizing knowledge requirements, (d) organizing classroom activities, (e) determining scope and sequence of curriculum.

Instructional Concept. A generalized idea of the composite skills and knowledge to be taught.

Key Occupations. Jobs in which 250 or more are employed and in which a five-year expansion/replacement need of 100 or more over a five-year period can be shown.

Performance Indicator. A description of student behavior which takes place within a prescribed setting (under certain conditions). Example: Given a list of colors and types of clothing, the student will identify those considered most safe for pedestrian use in various kinds of weather and illumination.

Preparation. Through the career cluster concept, students are given the opportunity to gain basic skills and knowledge related to a broad occupational area rather than to one occupation.

Related Occupations. Jobs in which 100 or more persons are employed in Oregon and among which similarities can be found.

Task. Any function a worker performs within a specific, continuous period of time and which results in an end product.

Task Inventory. A list of the duties and functions of a specific occupation which a worker performs in order to successfully hold the job.

Vocational Education. A component of career education which offers specific skill training in a wide variety of subtechnical, technical and subprofessional skills, which prepares individuals for gainful employment, and which may continue through skill upgrading or retraining for a new job.

World of Work. All existing job titles shown in the *Dictionary of Occupational Titles.*

PROVISIONS FOR APPROVAL

of

SECONDARY VOCATIONAL PROGRAMS

Section I. Statement of Assurances

The program will:

- be available for all
- be designed to prepare individuals for gainful employment in occupations other than those considered professional or those requiring a baccalaureate or higher degree
- be based on consideration of up-to-date skills and knowledge required in the cluster of occupations
- be based on advice and counsel of occupational representatives
- include guidance and counseling
- be conducted and supervised by qualified teachers
- provide for adequate facilities and equipment and safety of students
- combine related instruction with shop, lab and cooperative experience and other appropriate experience
- provide opportunity for students' involvement in vocational youth organizations
- provide for supervision and control of funds by local education agencies (LEA's)
- assure that federal funds will not supplant local funds, not be used for programs which do not prepare students for employment or advanced training, or which do not assist in making meaningful occupational choices
- assure a system for evaluation of objectives, and provide for modifications as recommended.

Section II. (Part A) Vocational Curriculum Assurances

The program will meet the following minimum standards:

- advisory committee minutes and member roster on file at LEA
- written contacts with all community resources used for student experiences
- provision for transition from secondary to post-secondary programs
- provision for ten instructional hours per week, or for 2 credit units
- adequate provision for:
  a. time and budget to supervise occupational experience programs
  b. travel time for vocational youth group activities by instructor
  c. travel time for in-service and state-called conferences
  d. time for program development and evaluation

Section II. (Part B) Minimum Standards For Specific Vocational Curricula

Agriculture

- 9th and 10th grade instruction plus 11th and 12th grade cluster
- supervised occupational experience
- Future Farmers of America (FFA) to be integral part of the program

Health

- consideration of state and national program standards, certification and licensing
- "live lab" experiences in clinical and/or community facilities

Marketing

- Distributive Education Clubs of America (DECA) to be integral part of the program
- supervised occupational experience

Office Occupations

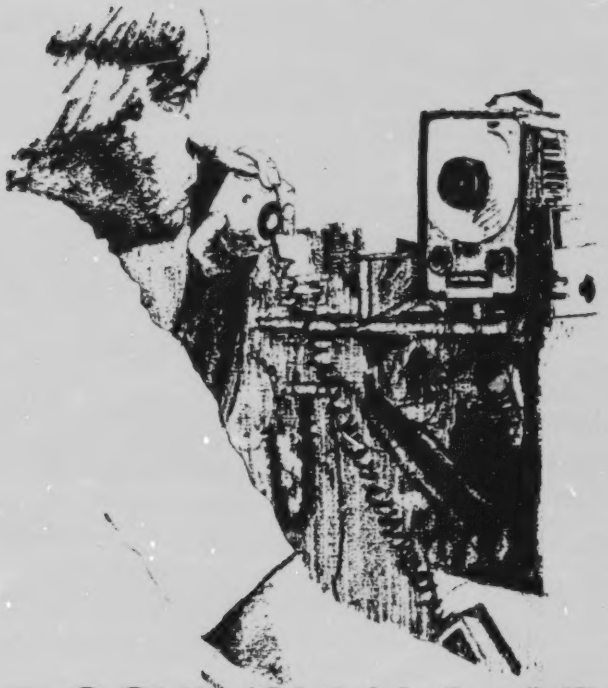
- Future Business Leaders of America (FBLA) to be an integral part of the program
- simulated office experience, co-op work experience and individualized instruction
- provision for occupational preparation rather than traditional course oriented approach

Gainful Homemaking

- Future Homemakers of America (FHA) to be an integral part of the program
- students will be identified in one of the following occupational areas:
  a. child care
  b. clothing management, production and services
  c. institution and home management and supporting services

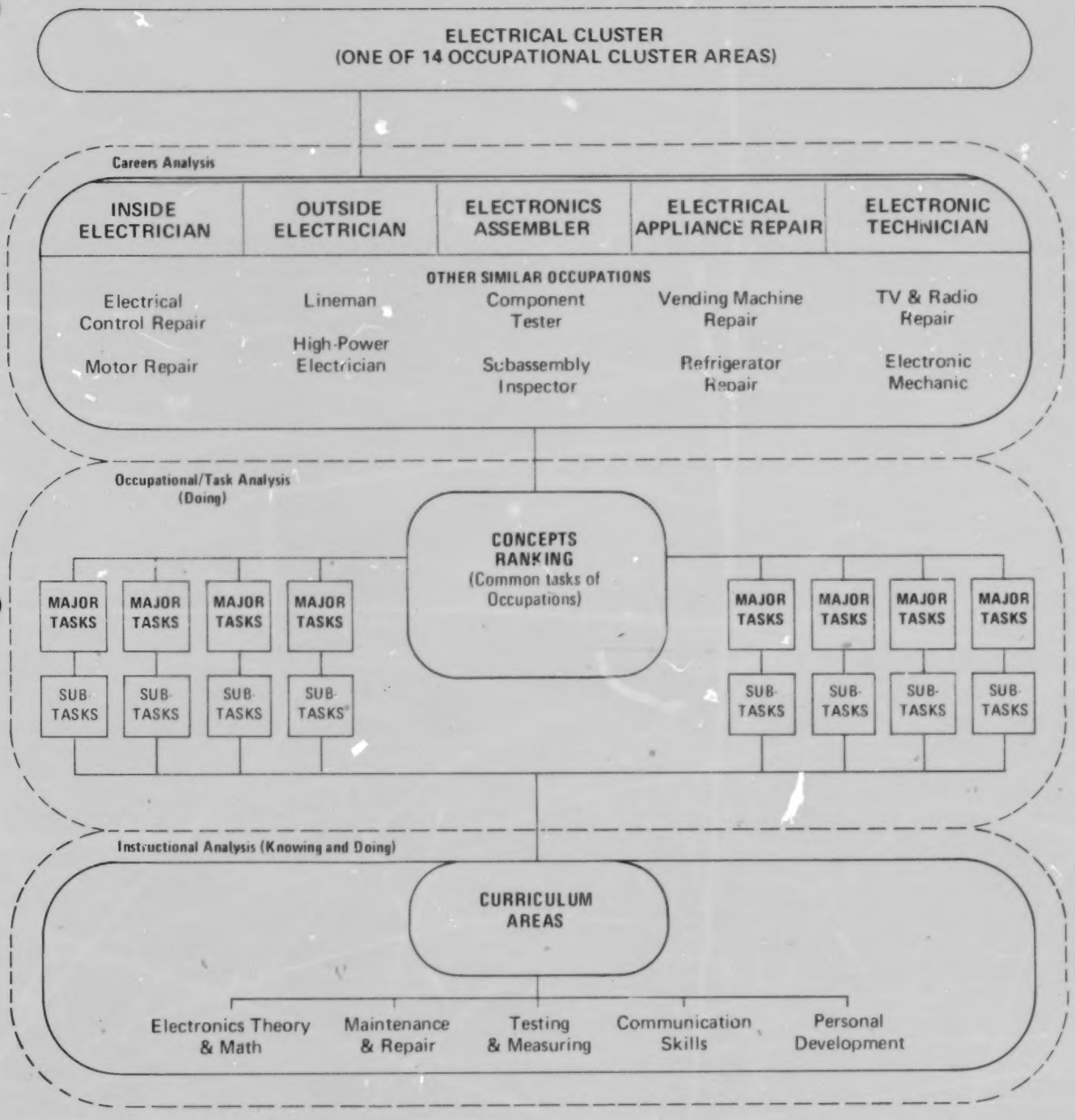
Mechanics, Metals, Construction, Electrical

- Vocational Industrial Clubs of America (VICA) to be an integral part of the program



OCCUPATIONAL AND INSTRUCTIONAL ANALYSIS

WORLD OF WORK



AVENUES OF FURTHER STUDY

- PRIVATE SCHOOLS
- UNIVERSITY
- EMPLOYMENT
- APPRENTICESHIP
- COMMUNITY COLLEGE

OREGON MANPOWER DATA

D.O.T. NO.	KEY OCCUPATIONS FOR ANALYSIS PROCESS	1971 EMP.	69-75 EXP. REPL.	D.O.T. NO.	KEY OCCUPATIONS 250 EMPLOYED 100 EXP/REPL.	1971 EMP.	69-75 EXP. REPL.	D.O.T. NO.	REL. OCCUPATIONS 100 OR MORE EMPLOYED	1971 EMP.	69-75 EXP. REPL.
003181	Electronics Technician	816	168					003081	Electronics Engineer	500	59
								003081	Telephone Engr.	136	18
								003187	Radio Engineer	120	20
								828281	Electronics Mech.	345	85
824281	Outside Electrician	2842	925	821381	Lineman	510	123	821131	Line Foreman	246	31
								821887	Groundman	250	45
								829381	Cable Splicer	495	50
827281	Electric Appliance Service	672	217					639381	Vending Machine Repair	242	82
								827281	Coffee Maker Service	123	78
720281	Inside Electrician	745	250					820781	Dynamo Man	176	66
								721281	Elect. Motor Repair	203	43
726781	Electronics Assembler	2285	235					726384	Inspector Subassemblies	294	35

TASK ANALYSIS FOR DETERMINING COURSE CONTENT

ON-THE-JOB-TASKS	OUTSIDE ELECTRICIAN	INSIDE ELECTRICIAN	ELECTRICAL APPLIANCE SERVICE	ELECTRONIC TECHNICIAN	ELECTRONICS ASSEMBLER
I. USES HAND TOOLS					
Screwdrivers, pliers, wire-strippers, etc.	X	X	X	X	X
Pipe benders	X	X	X		
Flaring tools	X	X	X	X	
Cutting and threading tools	X	X	X	X	X
Bearing pullers and installers		X	X		
Wire pulling equipment	X				
II. PREPARES & CONNECTS CABLES & WIRES					
Identifies wire & cable by size & color code	X	X	X	X	X
Cuts, strips, splices wire and cable	X	X	X	X	X
Laces, straps wire	X	X	X	X	X
Forms cable harnesses				X	X
Pulls & feeds wire in conduit and raceways	X	X		X	X
Connects wire to terminals	X	X	X	X	X
III. USES DIAGRAMS AND DRAWINGS					
Standard schematic symbols	X	X	X	X	X
Electrical abbreviations	X	X	X	X	X
Blueprints and specifications	X	X	X	X	X
Exploded pictorial views	X	X	X	X	X
Wiring pictorial views	X	X	X	X	X
Block diagrams	X			X	
Layout diagrams	X	X		X	X
Schematics	X	X	X	X	X
IV. ASSEMBLES, REPAIRS, INSTALLS, ELECTRICAL/MECHANICAL DEVICES AND EQUIPMENT					
Uses color codes	X	X	X	X	X
Connects switches, transformers, capacitors, etc.	X	X	X	X	X
Identifies electrical parts and components	X	X	X	X	X
Inspects/replaces protective & control devices (fuses, thermal switches, relays, etc.)	X	X	X	X	X
Inspects/replaces motors, generators, servos, etc.	X	X	X	X	X
Uses fastening devices (screws, bolts, rivets, etc.)	X	X	X	X	X
Identifies mechanical parts and components	X	X	X	X	X
Inspects/installs seals, hoses, pumps, etc.	X	X	X		
Inspects/replaces bearings, gears, pulleys, etc.		X	X		

TASK ANALYSIS FOR

DETERMINING COURSE CONTENT

ON-THE-JOB-TASKS	OUTSIDE ELECTRICIAN	INSIDE ELECTRICIAN	ELECTRICAL APPLIANCE SERVICE	ELECTRONIC TECHNICIAN	ELECTRONICS ASSEMBLER
V. MAINTAINS ELECTRICAL/MECHANICAL SYSTEMS					
Cleans	X	X	X	X	X
Inspects	X	X	X	X	X
Tests	X	X	X	X	X
Calibrates	X	X	X	X	X
Lubricates	X	X	X	X	X
Disassemble/Assemble	X	X	X	X	X
Determine repairability	X	X	X	X	X
Maintains logs and records	X	X	X	X	X
Troubleshoots	X	X	X	X	X
Makes safety inspections	X	X	X	X	X
Replaces defective components	X	X	X	X	X
VI. SOLDERS, BRAZES, WELDS					
Select and use proper irons, guns, temperature	X	X	X	X	X
Select and use proper solders and fluxes	X	X	X	X	X
Solder to established standards	X	X	X	X	X
Solder to printed circuit boards				X	X
Solder to terminals	X	X	X	X	X
Solder copper tubing		X	X		
Uses proper desoldering techniques			X	X	X
Identifies improper solder connections	X	X	X	X	X
Selects proper torches, fluxes and rods	X	X	X		X
Welds and brazes to established standards	X	X	X		X
VII. USES TEST EQUIPMENT					
Reads meters	X	X	X	X	X
VOM	X	X	X	X	X
VTVM			X	X	X
Oscilloscopes		X		X	X
Signal generators				X	X
Power supplies	X	X	X	X	X
Amprobe	X	X	X		
Megger	X	X	X	X	

TASK ANALYSIS FOR DETERMINING COURSE CONTENT

ON-THE-JOB-TASKS	OUTSIDE ELECTRICIAN	INSIDE ELECTRICIAN	ELECTRICAL APPLIANCE SERVICE	ELECTRONIC TECHNICAN	ELECTRONICS ASSEMBLER
VII. (Cont'd)					
Capacitance checker			X	X	X
Tube tester		X		X	
Counters				X	X
Transistor tester		X		X	
Isolation transformer	X		X	X	
Substitution boxes (resistance, capacitance)			X	X	
Growler		X	X		
VIII. APPLIES ELECTRICAL THEORY AND RELATED MATHEMATICS					
DC Theory	X	X	X	X	X
AC Theory	X	X	X	X	X
Passive devices (resistors, capacitors, inductors, etc.)	X	X	X	X	
Active devices (tubes and semiconductor devices)	X	X	X	X	
Calculates basic circuit characteristics	X	X	X	X	
IX. USES POWER TOOLS					
Electric hand drill	X	X	X	X	X
Drill press	X	X	X	X	X
Lathe and milling equipment		X		X	
Power threader	X	X			
Wire wrapping equipment				X	X
Stud gun	X	X	X	X	
Sabre saw	X	X	X	X	
Vacuum pump	X		X		
Brake (Sheet metal)		X		X	
X. GIVES AND RECEIVES TECHNICAL INSTRUCTIONS					
Maintains inventories of materials	X	X	X	X	X
Fills out time/job work sheets	X	X	X	X	X
Keeps cost and materials records	X	X	X	X	X
Phones in parts orders	X	X	X	X	
Writes formal and informal technical reports	X	X	X	X	X
Completes business forms	X	X	X	X	
Maintains safety records	X	X	X	X	X
Sketches electrical drawings	X	X	X	X	

TASK ANALYSIS FOR

DETERMINING COURSE CONTENT

ON-THE-JOB-TASKS	OUTSIDE ELECTRICIAN	INSIDE ELECTRICIAN	ELECTRICAL APPLIANCE SERVICE	ELECTRONIC TECHNICIAN	ELECTRONICS ASSEMBLER
X. (Cont't)					
Consult with inspectors, supervisors, peers, etc.	X	X	X	X	X
Deals with customers	X	X	X	X	
Uses drafting dimension systems	X	X	X	X	X
Uses data from graphs, tables and charts	X	X	X	X	X
Uses equipment manuals and parts catalogs	X	X	X	X	
Interprets name plate data	X	X	X	X	
Follows written sequential directions	X	X	X	X	X
Follows oral sequential directions	X	X	X	X	X
XI. INSTALLS ELECTRIC SERVICE AND EQUIPMENT					
Installs conduit, raceways, cables, fittings	X	X	X	X	X
Installs/connects fixtures and appliances	X	X	X		
Installs/connects grounding devices	X	X	X	X	X
Pulls and lubricates wires	X	X	X		
Installs boxes and panels	X	X		X	
XII. DEMONSTRATES PERSONAL DEVELOPMENT & LEADERSHIP SKILLS	X	X	X	X	X

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ELECTRICAL OCCUPATIONS CLUSTER ORGANIZATION AND IMPLEMENTATION

GOAL-BASED PLANNING FOR THE ELECTRICAL CLUSTER

Goals are guideposts. They serve to give purpose and direction to a planning activity. Goals provide a common language for discussing the merits of various activities as those activities are carried out.

In the electrical cluster, just as in any other instructional program offered by an educational system, a sense of purpose and direction is essential to good planning. But what are these purposes and directions? Where do they come from? Why should the electrical cluster teacher be concerned? These are questions to be answered before effective planning of an electrical cluster curriculum can proceed.

Each teacher must realize that planning an electrical cluster curriculum cannot begin and end only in a given classroom. It needs to be done with a sense of similar planning in other classrooms and districts within the state.

The goals, goal setting, and competency identification activities the Oregon Department of Education prescribes provide districts a common reference for the planning process. In goal-based planning, teachers must consider four goals: state goals for Oregon learners, district goals, program goals, course goals. They must also consider student competency and state defined competency areas.

State Goals answer the question: What does the Department of Education think a student should get out of public schooling anywhere in Oregon?

District Goals answer the question: What do the local community and its schools think a student ought to get out of local schooling and how is that to relate to State Goals?

Program Goals answer the question: What do the local curriculum planners and electrical cluster teachers think a student out to get out of the electrical cluster and how is that to relate to District Goals?

Course Goals (and Unit Goals—Elementary) answer the question: What do the electrical cluster teachers think a student ought to get out of technical communications, for instance, and how is that to relate to Program Goals?

State Competency Areas answer the question: What does the Department of Education believe to be the critical areas in which students must demonstrate competence for graduation?

Competency, then, answers the question: What have students demonstrated they can do with what they have learned?

The relationships among each of these components are illustrated on the following page. Note that competencies may be stated broadly (as with district goals) or specifically (as with course goals) depending on how extensive the district desires a particular demonstration to be. The sample competency in the figure is shown as being an intended outcome of both district *and* program level goal planning. Other competencies could be shown as the intended outcomes of district or course goal-level planning (broken lines).*

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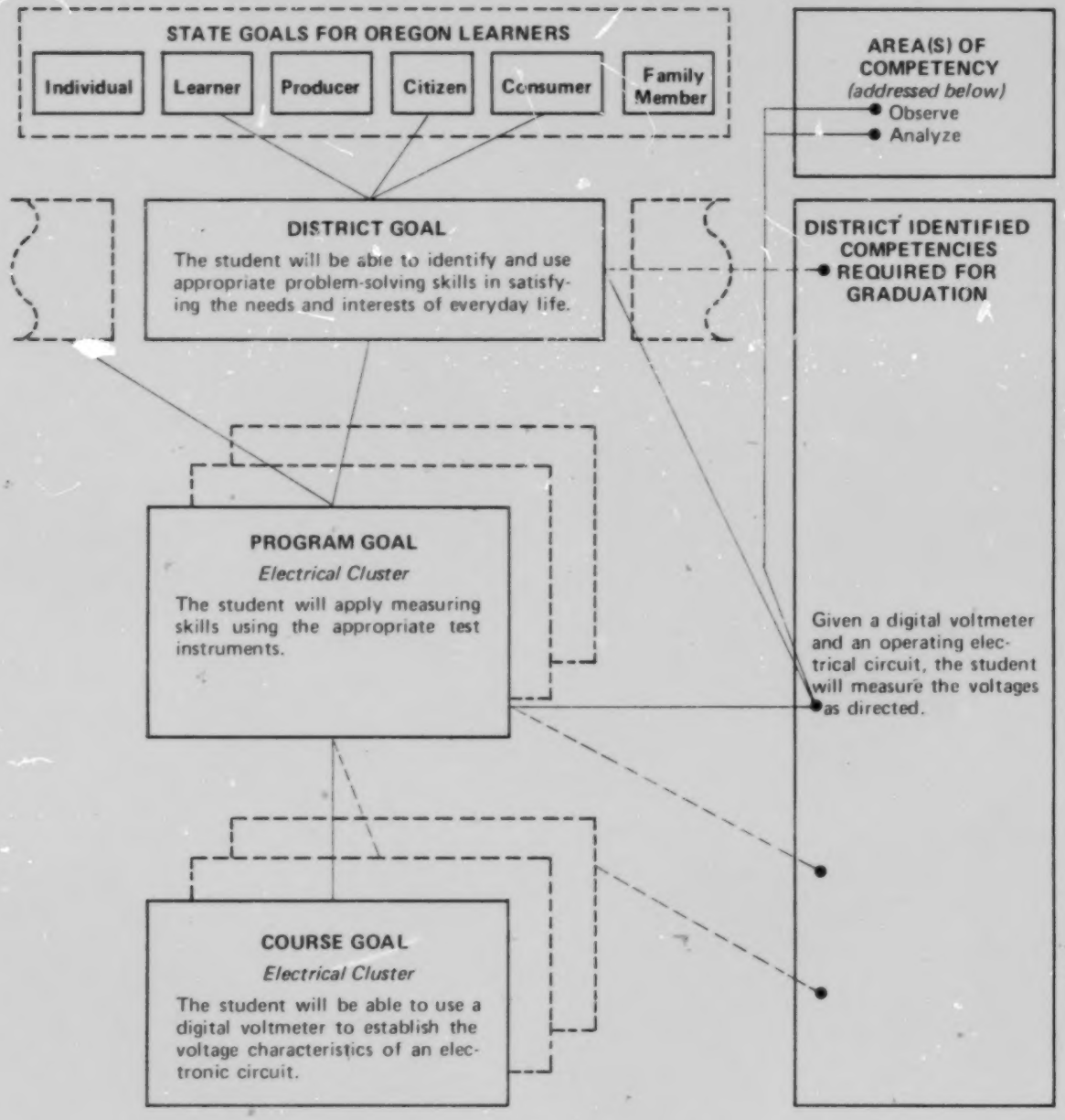
* All goals may not be competencies, but all competencies may be used as goals. Goals are often written about the *acquisition and application* of knowledge and skills. Competencies are ALWAYS written about the *application* of knowledge and skills.

The system of goals and competencies just described* is designed to help the teacher and program specialist plan their own electrical cluster program. It promotes a framework for planning that may be shared by all those doing similar planning. It helps in planning for individual student goals and interests, to be done within the limits of available resources. It should not be used to limit what is planned. Rather it should be used as a starting place.

SAMPLE COMPLEMENTARY GOALS & COMPETENCIES


STATE GOALS FOR OREGON LEARNERS
Individual
Learner
Producer
Citizen
Consumer
Family Member
AREA(S) OF COMPETENCY
(addressed below)
Observe
Analyze
DISTRICT GOAL
The student will be able to identify and use appropriate problem-solving skills in satisfying the needs and interests of everyday life.
DISTRICT IDENTIFIED COMPETENCIES REQUIRED FOR GRADUATION
PROGRAM GOAL
Electrical Cluster
The student will apply measuring skills using the appropriate test instruments.
Given a digital voltmeter and an operating electrical circuit, the student will measure the voltages as directed.
COURSE GOAL
Electrical Cluster
The student will be able to use a digital voltmeter to establish the voltage characteristics of an electronic circuit.

* For more information on goal-based planning, see Oregon Department of Education publications *Elementary-Secondary Guide for Oregon Schools: Part II, Suggestions* (1977) and *Planning the Education of Oregon Learners: Setting Goals* (1975).

OBJECTIVE OF THE ELECTRICAL CLUSTER

The objective of the electrical cluster is to provide opportunities for individuals to acquire a broad conceptual knowledge and entry-level skills in:

1. appropriate technical communications
2. basic electrical theory and related mathematics
3. electro-mechanical construction, installation, maintenance and repair
4. proper and appropriate use of test equipment
5. personal development and leadership skills

While these skills are considered basic to the electrical cluster, supplementary objectives should be developed by teachers for various age and grade levels.

INDIVIDUALIZED INSTRUCTION

By its very nature, the cluster concept demands the use of some method of individualized instruction. No matter what method is used, it should be based on student performance that is measurable.

The use of an individualized learning system requires a reorientation of the instructor's role. The instructor becomes a counselor and a director to help guide the student through the system which he or she established. The instructor answers questions on an individual basis. He or she occasionally lectures to the whole class. He or she holds small-group seminars and discussions. Maintaining a record of the student's progress is also important.

An in-service program will be needed to orient the instructor to his or her new role and to the proper ways of implementing and directing the individualized learning system.

Any individualized system should be able to do the following:

1. Give credit for previously learned and demonstrated skills,
2. Allow the student to pause for remedial assistance, and then resume his/her studies,
3. Inform each student of the specific behavioral outcomes for which he/she will be responsible,
4. Allow the student to progress individually,
5. Monitor each student's progress.

ELECTRICAL CLUSTER CURRICULUM

The guide which follows is designed to provide qualified teachers with "educational specifications" for specific knowledge and skills that will qualify students for *entry-level employment* in the electrical occupations listed in the "World of Work" chart. It must be remembered that in the apprenticeable trades an apprenticeship of two to four years will follow upon employment. The teacher will have to organize the specifications to assure students the training that will fit their individual needs and desires.

An electrical program should encompass:

Occupational exploratory experiences in grades seven through ten. They are of prime importance to students in developing career goals and plans. Courses in industrial arts, general business, industrial English, mathematics, and science will provide valuable experiences leading to the electrical cluster in grades 11 and 12.

Occupational guidance. Helping students to learn more about themselves and to choose an occupational field which will offer them both challenge and self-fulfillment is the heart of a successful occupational education program.

Electrical cluster courses in grades 11 and 12. These courses should be allocated a segment of time approximating two periods per day or ten hours per week. This amount of time is minimal for the study and experience required to achieve the curriculum objectives. The education specifications for these courses begin on page 24. *The following major areas appear in these specifications, but they are not presented in any required sequence:*

1. Appropriate use of technical communications,
2. Proper use of test equipment,
3. Electro-mechanical construction, installation, maintainance and repair,
4. Basic electrical theory and related math,
5. Personal development and leadership skills.

Allied supporting elective courses in grades 11 and 12. The student should be able to choose supplemental learning experiences which will sharpen his/her particular interests and talents and help him/her attain occupational objectives. A list of recommended allied supporting elective courses is suggested on page 25.

Cooperative work experience programs. These should be approved by the Division of Instructional Support, Career Education, but could make up a portion of the required time blocks. A Department of Education publication entitled *Work Experience Manual* will supply details on establishing such a program. A suggested electrical cluster curriculum plan is presented on page 24.

The Department of Education recognizes that each local school district will encounter unique problems in scheduling when undertaking the implementation of the secondary occupational cluster program. The suggested time blocks are governed by the State Plan for Vocational Education, and within those limitations are flexible and can be adapted to the needs of the local school district.

A SUGGESTED CURRICULUM PLAN
ELECTRICAL CLUSTER CURRICULUM

Period	Grades 7 and 8	Grade 9	Grade 10	Grade 11	Grade 12
I	Social Studies	Communication Skills	Communication Skills	Communication Skills	Communication Skills
II	Language Arts	Mathematics	Mathematics II or Algebra	U.S. History	Humanities Elective
III	Mathematics	Health and Physical Education	Health and Physical Education	Health and Physical Education	Applied Physics, Business Law, Bookkeeping, Economics, Speech, Data Processing
IV	Health and Physical Education	Science	Science	*Allied Supporting Elective (Applied Math)	*Allied Supporting Elective (Applied Math)
V	Science, General Music	**Industrial Arts (Exploratory)	****Industrial Arts (Drafting) (Basic Electricity–Electronics)	Electrical Cluster Course	Electrical Cluster Course
VI	Arts, Homemaking, **Industrial Arts	General Business (Exploratory) Careers Orientation		***Communications	

*NOTE: See page 25 for a complete listing of allied supporting courses.
**Functions of Industry—Materials and Processes, Power and Mechanics, Electricity/Electronics, Graphics/Communications.
***Includes basic entry knowledge and skills related to mathematics and verbal and nonverbal communication identified within the electrical industry. Taught as an interrelated part of the total cluster curriculum.
****Semester offerings.

Occupational Specialty Courses

Curriculum Electives

Required Courses

SUGGESTED ALLIED SUPPORTING COURSES

The following list of allied supporting courses is recommended to students planning to enter, or those already enrolled in, the electrical cluster curriculum.

Industrial arts programs provide many of the opportunities mentioned in the course descriptions, although course titles do not remain constant. This does not limit their scope or effectiveness in supplying learning experiences in these areas. In most cases, the existing program, with only slight modification of content, will provide the experiences suggested in the following course descriptions.

Courses generally found in the high school curriculum such as Basic Economics, Speech, Technical Writing, General Science, Mathematics through Trigonometry, etc., also are supporting courses and should be considered when choosing electives.

The student must consider all courses available and discuss various alternatives with his parents, school counselors, and advisors. This will help him choose an educational program with realistic career-oriented experiences and objectives.

Basic Metalworking and Machine Tools

A course designed to provide learning experiences dealing with the fundamentals of basic metals and machine tools used in industry. Included in the laboratory course will be the theory and application of machine tools to forming and shaping of metals most commonly found and used in industry to fabricate machine parts and assemble components. During the course, the student will learn the basic operation of the drill press, lathe, shaper, and grinder. Some basic metallurgy will also be considered for discussion and experimentation.

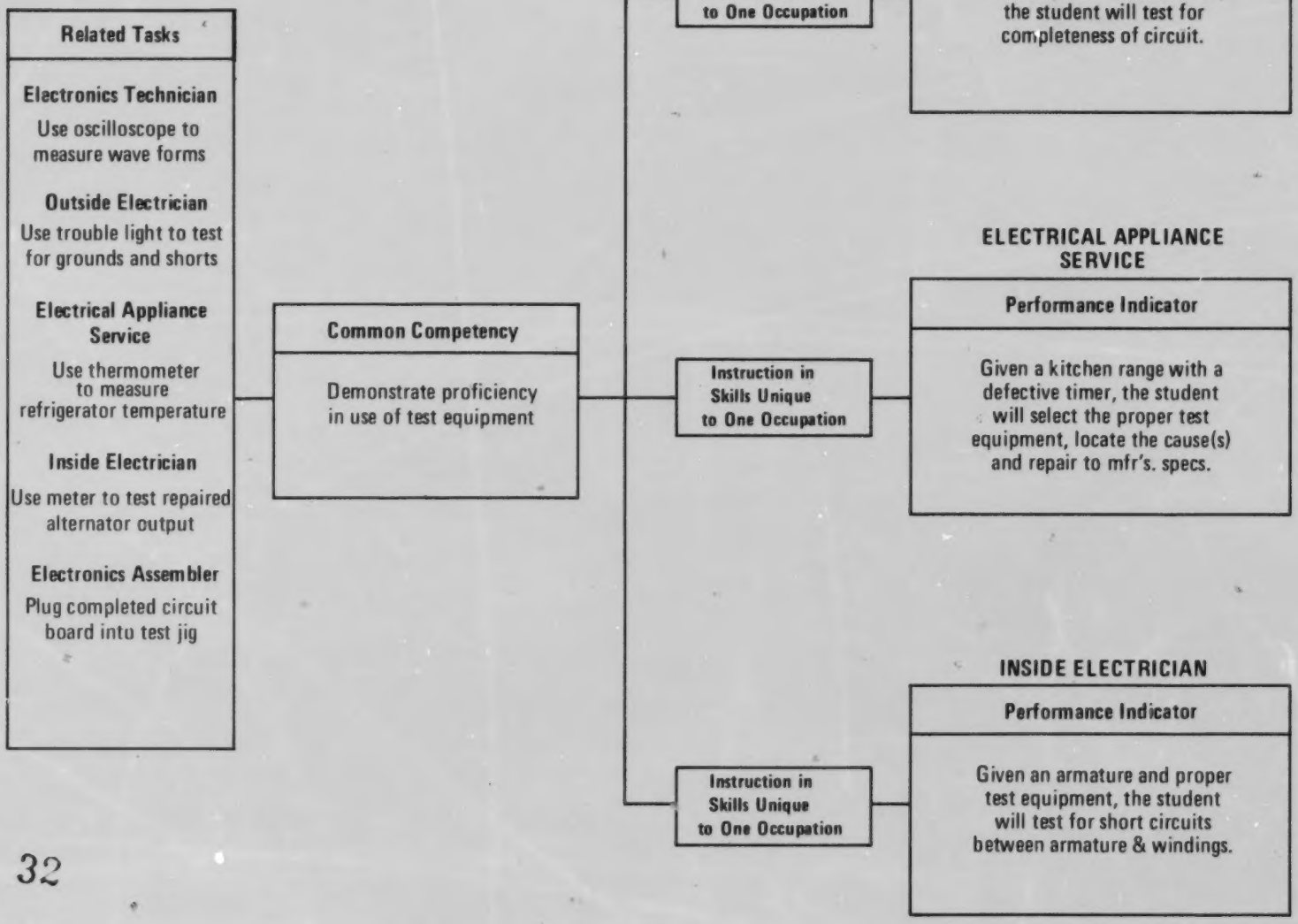
Welding Fundamentals

A lecture, demonstration, and laboratory course covering the fundamentals of electrical welding, soldering, brazing of ferrous and nonferrous metals. Technical information is correlated with manipulative practice to provide an opportunity for the student to become familiar with methods in fabrications used in repair and maintenance.

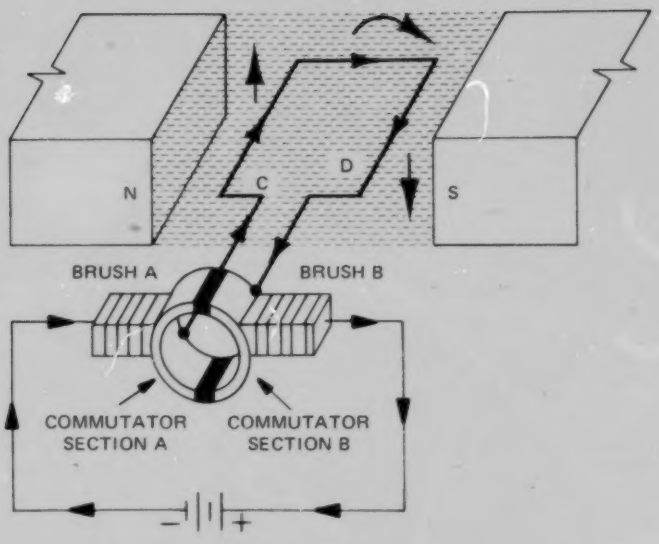
Graphic Communications

A course designed to introduce the student to the area of graphic communications, i.e., the methods and mechanics by which individuals in modern industry communicate ideas and concepts. Included in the course are instruction and practice in principles of visualization, oral communication, technical sketching, basic drafting, blueprint reading, shop processes, specification and tolerancing, photography and printing. Specific technical information is correlated with laboratory experiences to provide an opportunity for students to develop a fundamental concept of methods by which human beings communicate ideas through schematic drawings, blueprints, technical service manuals and conversations.

RELATIONSHIP OF COMMON AND UNIQUE SKILLS IN AN OCCUPATIONAL SETTING


Related Tasks
Electronics Technician
Use oscilloscope to measure wave forms
Outside Electrician
Use trouble light to test for grounds and shorts
Electrical Appliance Service
Use thermometer to measure refrigerator temperature
Inside Electrician
Use meter to test repaired alternator output
Electronics Assembler
Plug completed circuit board into test jig
Common Competency
Demonstrate proficiency in use of test equipment
Instruction in Skills Unique to One Occupation
Instruction in Skills Unique to One Occupation
Instruction in Skills Unique to One Occupation
ELECTRONICS TECHNICIAN
Performance Indicator
Given a continuity tester and a repaired circuit board, the student will test for completeness of circuit.
ELECTRICAL APPLIANCE SERVICE
Performance Indicator
Given a kitchen range with a defective timer, the student will select the proper test equipment, locate the cause(s) and repair to mfr's. specs.
INSIDE ELECTRICIAN
Performance Indicator
Given an armature and proper test equipment, the student will test for short circuits between armature & windings.

INSTRUCTIONAL EMPHASIS AREAS



Construction and theory of a simple d-c motor.

TECHNICAL COMMUNICATIONS

Program Goals

The program goals listed below relate to all the course goals, competencies, performance indicators and activities listed in this chapter. These program goals are grouped here for easy reference.

1. The student will be able to communicate in technical terms.
2. The student will be adept in the analyzation of electronic circuits.
3. The student will acquire skills in the assembly, maintenance and repair of electronic equipment.
4. The student will be able to apply theoretical electronics and mathematical concepts to the analysis of a circuit.
5. The student will be able to speak, read, write in a manner which will demonstrate maturity and leadership.

COMPETENCIES: The Student will be able to:

1.1 use color codes.

1.2 use schematic drawings.

PERFORMANCE INDICATORS:

1.1.1 Given a group of 20 different resistors, the student will be able to list, from memory, the value, tolerance and power rating of each resistor.

1.1.2 Given a power transformer, the student will be able to write the function of each winding.

1.1.3 Given a standard 3-wire power cord, the student will be able to identify each lead by its color.

1.2.1 Given a sketch of an electrical circuit, the student will be able to create an acceptable electrical schematic to the instructor's satisfaction.

1.2.2 Given an untitled schematic drawing, the student will be able to write and/or print letters or titles, etc., where required, in a legible form.

SUGGESTED LEARNING ACTIVITIES:

Color codes, Module EL-RS-26 (NOTE: EL Module numbers are new designators for the individualized curriculum for electronics. Packages may be ordered from Division of Continuing Education Publications, PO Box 1491, Portland, OR 97207, using either the ICE or EL designators.)

Schematics, diagrams and layouts, Module EL-RS-24.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 1. The student will be able to use appropriate technical communications skills.

COMPETENCIES: The Student will be able to:

1.3 use layout diagrams.

1.4 use a block diagram.

PERFORMANCE INDICATORS:

1.3.1 Given the components with which to build an electrical circuit, the student will be able to create a component layout drawing to the instructor's satisfaction.

1.3.2 Given a layout drawing, the student will be able to create an acceptable wiring diagram to the instructor's satisfaction.

1.3.3 Given a supply of components (i.e., resistors, capacitors, signal diodes and signal transistors), a circuit schematic, and a supply of 10 divisions to an inch graph paper, the student will be able to make a layout drawing for a P.C. Board. No copper clad may be wasted and all current paths must be electrically correct. Workmanship must be to the instructor's satisfaction.

1.3.4 Given a supply of copper clad, a component layout drawing and a supply of resist, the student will be able to apply the resist to the copper clad as shown on the layout drawing. The result must be a direct copy of the layout drawing with zero percent error. Workmanship must satisfy the instructor.

1.4.1 Given a schematic drawing, the student will be able to make a block diagram of the drawing indicating DC, AC, and signal paths where applicable.

SUGGESTED LEARNING ACTIVITIES:

Printed circuit etching, Module EL-RS-23.

Provide laboratory activity which allows student to make one or two technical sketches, blueprints, schematics, working drawings, and dimensioning to them.

Have the student draft a drawing or blueprint. (Perhaps a representative from a local architectural firm could participate and discuss the actual use.)

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 1: The student will be able to use appropriate technical communications skills.

COMPETENCIES: The Student will be able to:

1.5 use exploded pictorial views.

1.6 use wiring pictorial views.

1.7 use sketches, electrical drawings.

PERFORMANCE INDICATORS:

1.5.1 Given pictorial and wiring drawings and an electromechanical device, the student will be able to assemble and disassemble electromechanical equipment following working drawings.

1.7.1 Given paper, pencil and a simple electrical device, the student will be able to sketch ideas to convey his/her meaning to others. He/she will be able to read, sketch, and communicate mechanical concepts, such as the electrical light and brake system hook-up for a trailer to car connector.

1.7.2 Given a simple sketch, the student will be able to interpret basic sketches of electrical/mechanical equipment and machinery.

1.7.3 Given a simple device, the student will be able to make basic sketches of mechanical equipment and machinery to display operational characteristics.

SUGGESTED LEARNING ACTIVITIES:

Have student draw out and compare to actual system any electrical system, i.e., lights, ignition, starting, charging, etc. Also have student study fluid power system and fuel system.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 1: The student will be able to use appropriate technical communications skills.

COMPETENCIES: The Student will be able to:

1.8 use blueprints and specifications.

1.9 use drafting dimension systems.

PERFORMANCE INDICATORS:

1.8.1 Given a blueprint, the student will be able to read and follow the blueprints of electrical/mechanical systems.

1.9.1 Given a pictorial drawing, the student will be able to interpret such things as tolerancing and dimensioning or assign basic specifications to his/her own drawings.

SUGGESTED LEARNING ACTIVITIES:

Provide laboratory activities which allows student to interpret blueprints of electrical/mechanical systems.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 1: The student will be able to use appropriate technical communications skills.

COMPETENCIES: The Student will be able to:

1.10 use equipment manuals and parts catalogs.

PERFORMANCE INDICATORS:

1.10.1 Given an instruction manual for reference, the student will be able to state the two major purposes of the manual.

1.10.2 Given sample instruction manuals, the student will be able to list at least eight of the approximately twelve sections of information which are included in most complete instruction manuals.

1.10.3 Given an instruction manual, the student will be able to locate information on:

a. purpose or specifications of the device
b. operation of the device
c. where to write for parts or information
d. schematic or wiring diagram
e. parts list
f. troubleshooting charts
g. calibration information.

1.10.4 Given an instruction and/or manual, the student will be able to list the kinds of information it provides.

1.10.5 Given an instruction manual, the student will be able to locate a specified part of the device in the schematic and/or wiring diagram and in the parts list.

1.10.6 Given parts books, specifications manuals and charts, drawings and diagrams, the student will be able to complete an assignment.

SUGGESTED LEARNING ACTIVITIES:

Have student list items for each performance indicator.

Have student locate manual storage area.

Have student read operating manual, identify operating controls, list the effect each control has on the equipment.

Use shop manuals to help student learn to identify models and engines and to look up necessary specifications, adjustments, procedures and wiring diagrams.

Use parts manuals to teach student to acquire proper parts by number, name and measurement.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL 1: The student will be able to use appropriate technical communications skills.

COMPETENCIES: The Student will be able to:

1.11 interpret nameplate data.

1.12 use data from graphs, tables and charts.

PERFORMANCE INDICATORS:

1.11.1 Given a nameplate from a device the student will be able to determine the operating voltage, current and power requirements.

1.12.1 Given a problem involving graphic analysis, the student will be able to state why graphs are so valuable in technical fields. The explanation should include a description of the functions of graphs.

1.12.2 Given a graph, the student will be able to do the following as directed:

a. Name the independent, dependent and fixed variables.
b. Locate any designated set of values of the variables to the graph's accuracy level.

1.12.3 Given a set of graphs showing typical curves, the student will be able to identify the shapes of the curves and explain, in general terms, what they tell us about the relationship between the variables. The curves are listed in the ILS package, and the student will be asked to discuss any four of them.

1.12.4 Given a table of values, the student will be able to plot a graph to the satisfaction of the instructor.

SUGGESTED LEARNING ACTIVITIES:

Do this from the nameplate of each instrument in the laboratory.

Reading graphs, Module EL-RS-28.

Making a graph, Module EL-RS-29.

Logarithmic and polar graphs, Module EL-RS-30.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 1: The student will be able to use appropriate technical communications skills.

COMPETENCIES: The Student will be able to:

1.12 use data from graphs, tables and charts. (continued)

1.13 keep costs and materials records.

PERFORMANCE INDICATORS:

1.12.5 Given a set of statistics, the student will be able to draw an acceptable graph of each of the following types:

a. semi-logarithmic
b. logarithmic
c. polar

1.12.6 Given a graph showing the static characteristics of any component, the student will be able to write the response of that component to a given set of circumstances.

1.12.7 Given a set of collector curves, the student will be able to plot the maximum power dissipation curve for a specified transistor.

1.12.8 Given a circuit diagram and a set of collector characteristics, the student will be able to construct the DC and AC load lines of a transistor amplifier.

1.13.1 Given paper and pencil, the student will be able to list the five essential records that a business must maintain and describe the information contained in each type of record.

SUGGESTED LEARNING ACTIVITIES:

Business forms and keeping records, Module EL-RS-46.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 1: The student will be able to use appropriate technical communications skills.

COMPETENCIES: The Student will be able to:

1.14 maintain inventories of materials.

1.15 fill out job/time work sheets.

1.16 complete business forms.

PERFORMANCE INDICATORS:

1.14.1 Given a set of record keeping forms currently in use, the student will be able to keep actual records for:

a. receiving parts shipments
b. repairing an item for a customer
c. inventory of parts
d. calibration of equipment
e. recording receipts for repair work done, when the situation permits.

1.15.1 Given the proper forms and instruction, the student will be able to keep accurate time reports and work records.

1.16.1 Given the proper forms and instruction, the student will be able to keep accurate time reports and work records.

SUGGESTED LEARNING ACTIVITIES:

Laboratory control and administration activities can be charted with the student as a learning experience.

Job forms and work orders should be acquired from a local commercial printer.

Job forms and work orders should be acquired from a local commercial printer.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 1: The student will be able to use appropriate technical communications skills.

COMPETENCIES: The Student will be able to:

1.17 use parts catalogs.

1.18 phone in parts orders.

1.19 maintain safety records.

PERFORMANCE INDICATORS:

1.17.1 Given catalogs, order forms and/or letters, the student will be able to prepare an accurate requisition or order for any designated list of common electrical or electronic parts.

1.18.1 Given catalogs, order forms and/or letters, the student will be able to prepare an accurate requisition or order for any designated list of common electrical or electronic parts.

1.19.1 (Generate your own performance indicator)

SUGGESTED LEARNING ACTIVITIES:

Industrial catalogs: Allied Radio parts catalog; Newark Electronics parts catalog.

The student should look up and order parts, tools and equipment from catalogs and enter on proper order blanks.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 1: The student will be able to use appropriate technical communications skills.

COMPETENCIES: **The Student will be able to:**

1.20 write formal and informal technical reports.

1.21 consult with inspector, supervisor, peers, etc.

1.22 deal with customers.

PERFORMANCE INDICATORS:

1.20.1 Given a subject and writing materials, the student will be able to write a technical report which has acceptable form and content.

NOTE: The objective is limited to form and content. This is not meant to imply that grammar, style and spelling are unimportant. To go beyond form and content would require developing a long sequence of learning packages which would, in effect, amount to an English course.

1.21.1 The student will be able to benefit from supervisory instruction by:

a. being prepared
b. accepting instruction
   1. repeating steps to him or herself
   2. connecting learning with what he/she already knows
   3. learning steps in logical order
   4. knowing what, why, when, where and how to do the job.
c. performing the job
d. producing.

1.22.1 (Generate your own performance indicators)

SUGGESTED LEARNING ACTIVITIES:

Simulate game applying four-step method of instruction.

Investigate methods used by various businesses.

Have student look at the illustrated booklet, *An Interpersonal Communication Primer*, available at the Oregon Department of Education.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: **1: The student will be able to use appropriate technical communications skills.**

COMPETENCIES: **The Student will be able to:**

1.23 follow written, sequential directions.

1.24 follow oral, sequential directions.

1.25 accomplish speech preparation and delivery.

PERFORMANCE INDICATORS:

1.23.1 (Generate your own performance indicators)

1.24.1 (Generate your own performance indicators)

1.25.1 Given a subject and appropriate resource materials, the student will be able to prepare and deliver speeches that:

a. inform
b. entertain
c. persuade.

1.25.2 Given the guidelines below, the student will be able to select a topic or subject for a formal speech and develop the speech for presentation by logical application of the following steps:

a. Limit scope and speak on subject of interest to the audience.
b. Gather materials from various media.
c. Narrow the topic; be specific; outline and consider time factor.
d. Use index cards for notes, title of the talk, introductions; state reason for talk; develop body of talk and draw conclusions.
e. Practice and revise the speech.
f. Make the presentation.

SUGGESTED LEARNING ACTIVITIES:

Have student practice developing appropriate topics, titles and resumes of the three general types of speeches.

Have student develop and present the three types of speeches.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: **1: The student will be able to use appropriate technical communications skills.**

COMPETENCIES: **The Student will be able to:**

1.26 use standard schematic symbols.

1.27 use electrical abbreviations.

PERFORMANCE INDICATORS:

1.26.1 Given 25 schematic symbols, the student will be able to write the names of at least 20.

1.26.2 Given the names of 25 electrical devices, the student will be able to draw the schematic symbols for a least 20.

1.26.3 Given a vacuum tube and an integrated circuit, the student will be to label the output terminal numbers of tubes and integrated circuits (TO-5, dual-in-line, etc.) in the accepted order.

1.27.1 Given 25 electrical abbreviations, the student will be able to write the names of at least 20.

1.27.2 Given 25 electrical names having standard abbreviations, the student will be able to write the standard abbreviation for at least 20.

SUGGESTED LEARNING ACTIVITIES:

Have the student draw the schematic diagram of a small radio.

Have the student dismantle a TV or radio for parts identification.

Have the students interact using flash cards.

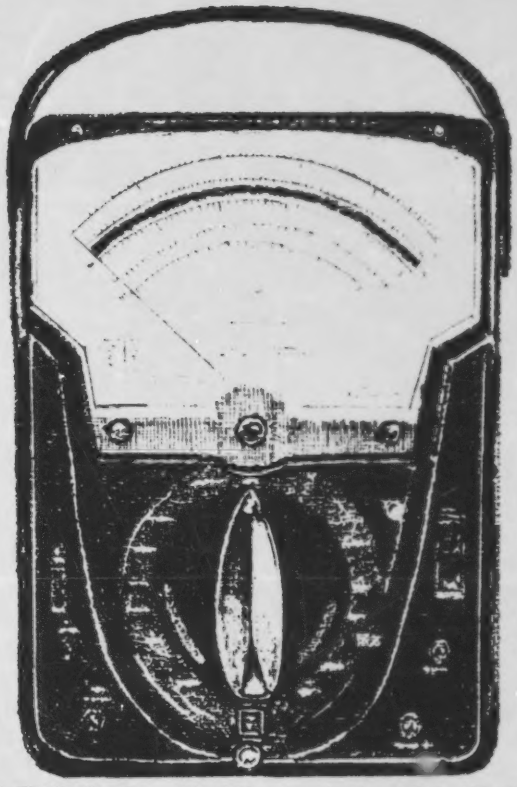
Have the student study the chart: "Electronic Schematic Symbols," EICO, Long Island City, New York. Notebook size charts provide comprehensive reference for electronic symbols and hardware.

Ref: (for instructor or library reference shelf) *IEEE Dictionary of Electrical and Electronic Terms* Wiley Interscience, 1972 IEEE Std. 100-1972.

Have the student study individualized Learning Systems packages on basic symbols. EL-RS-25.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL **1: The student will be able to use appropriate technical communications skills.**



TESTING AND MEASURING

COMPETENCIES: **The Student will be able to:**

2.1 read meters.

PERFORMANCE INDICATORS:

Reading Meters

2.1.1 Given a drawing of a linear meter scale with four pointer positions indicated and the range switch positions shown, the student will be able to accurately interpolate and read the value indicated.

2.1.2 Given a drawing of a nonlinear meter scale with the pointed position indicated and the range switch position shown, the student will be able to accurately interpolate and read the value indicated.

2.1.3 Given a drawing of a linear meter scale and pointer position and the full scale accuracy of the meter, the student will be able to calculate both the percent accuracy and actual error of the meter reading to within two significant figures.

Basic Meters

2.1.4 Given the necessary parameters, the student will be able to calculate the resistance values for a multiplier resistor, shunt resistor or ohmmeter circuit to the instructor's satisfaction.

2.1.5 Given a basic meter movement, the student will be able to construct the necessary circuitry around the meter to convert it into a voltmeter, an ohmmeter and a milliammeter.

2.1.6 Given the basic meter movement parameters, the student will be able to calculate the loading effect of the meter on a circuit as specified by the instructor.

SUGGESTED LEARNING ACTIVITIES:

Reading meters, Module EL-IO-01.

Have class view an instructional tape/slide program:
- reading scales
- measuring volts
- measuring amps
- measuring ohms

The programs are available from Division of Continuing Pub., Portland State University.

View the film: *Circuit Testing*, U.S. Army or University of Iowa, 33 minutes. (Address for this and other films in Appendix on Media.)

View the film: *Electricity Measurement*, Indiana University (rental), 12 minutes.

Basic meters, Module EL-IO-02.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL 2: **The student will be able to use the appropriate test equipment for measurement and evaluation of electronic circuits.**

COMPETENCIES: **The Student will be able to:**

2.2 use volt, OHM, milliammeter (VOM).

2.3 use vacuum tube volt meter (VTVM).

PERFORMANCE INDICATORS:

2.2.1 Given a VOM and a circuit, the student will be able to properly connect the meter into a circuit for measuring either current, voltage or resistance.

2.2.2 The student will be able to explain the reasons why a VOM is connected into a circuit the way it is to read either current, voltage or resistance; the student will also be able to explain the hazards of an improper connection.

2.3.1 Given a VTVM, the student will be able to set up and adjust it and measure any voltage as directed, to the satisfaction of the instructor. The voltages will include high and low AC and DC. AC measurements will be RMS and peak-to-peak.

2.3.2 Given the resistors, the student will be able to measure the resistance of ten unknown resistances to the accuracy which the VTVM allows.

2.3.3 Given schematics showing resistance values and approximate voltage drops, determine whether a VOM or VTVM, both or neither, would be suitable for measuring the voltage without producing excessive loading effect error.

SUGGESTED LEARNING ACTIVITIES:

The VOM, Module EL-IO-04.

Look at the instructional tape/slide program: *The VOM*. Div. of Continuing Publications, Portland State University.

Determine total resistance of several resistances in series or parallel, using an ohmmeter.

Have student measure resistances of unknown resistors.

Have student construct a simple continuity tester.

The VTVM, Module EL-IO-03.

View the instructional tape/slide program: *The VTVM*, Division of Continuing Publications, Portland State University.

Use a VTVM to measure various battery and power supply voltages.

Use blown-up photographic model with movable indicator for demonstration purposes.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL 2: **The student will be able to use the appropriate test equipment for measurement and evaluation of electronic circuits.**

COMPETENCIES: **The Student will be able to:**

2.4 use a digital voltmeter.

2.5 use a power supply.

PERFORMANCE INDICATORS:

2.4.1 Given a digital voltmeter (DVM), the student will be able to make voltage readings within the range of the DVM.

2.4.2 Given a DVM, the student will be able to set the controls correctly.

2.4.3 Given a DVM, a VCM and a VTVM, the student will be able to compare the characteristics, advantages and disadvantages of each.

2.5.1 Given a high voltage and low voltage supply, the student will be able to describe the functions of the front panel controls and demonstrate a safe procedure for making circuit changes and measurements.

2.5.2 Given the operating manual of a power supply, the student will be able to list the voltages available, the current maximums, the overload protection used and the regulation and ripple ratings.

2.5.3 Given a VOM or VTVM, the student will be able to adjust the power supplies used in the lab to any value within their operating range.

2.5.4 Given the appropriate materials, the student will be able to explain the test conditions under which they must use an isolation transformer and demonstrate how to properly use the type of isolation transformer available in their lab.

SUGGESTED LEARNING ACTIVITIES:

Have student study EL-IO-09 on the digital voltmeter.

Have students study EL-IO-05 on power supplies.

View the instructional tape/slide program: *Power Supplies*, Div. of Continuing Publications, Portland State University.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL 2: **The student will be able to use the appropriate test equipment for measurement and evaluation of electronic circuits.**

COMPETENCIES: **The Student will be able to:**

2.6 use signal generators (AF and RF).

PERFORMANCE INDICATORS:

2.6.1 Given an operator's manual for any signal generator, the student will be able to look up and list the frequency range, rated output and output impedance on the one-volt output range.

2.6.2 Given a AF or RF generator and an oscilloscope as a monitor, the student will be able to adjust the output voltage and frequency of the generator to any value within the generator's range.

2.6.3 Given an oscilloscope or VTVM and a variable resistance, the student will be able to approximate the output impedance of a signal generator on ranges other than the reference (one-volt range).

SUGGESTED LEARNING ACTIVITIES:

AF and RF signal generators, Module EL-IO-06.

View the instructional tape/slide program: *Audio Generator*, Div. of Continuing Publications, Portland State University.

Connect signal generator to an oscilloscope and visually show graphic representations of various frequencies.

Connect generator to speaker and vary frequency to show effects of audio frequencies.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL 2: **The student will be able to use the appropriate test equipment for measurement and evaluation of electronic circuits.**

COMPETENCIES: The Student will be able to:

2.7 use an oscilloscope (general purpose).

PERFORMANCE INDICATORS:

2.7.1 Given a general purpose oscilloscope, the student will be able to rapidly, and with a minimum of hesitation, set up the scope available in their lab and perform the following indicators to instructor's satisfaction:

a. Display and stabilize any waveform designated.
b. Measure the voltage amplitude of the waveform.
c. Measure phase relationship between two signals.
d. Compare the frequency of two signals and, when one signal is of known frequency, measure the frequency of the unknown.
e. Explain the purpose and application of the direct probe, low capacity probe, and the RF probe.

SUGGESTED LEARNING ACTIVITIES:

General purpose oscilloscopes, Module EL-IO-07.

Measure unknown voltages with oscilloscope and verify readings with meter which reads p-p.

Use oscilloscope to determine phase relationship between the voltage and current in a coil.

View the film: *The Oscilloscope Draws a Graph*, Tektronix Corp., Beaverton, Oregon.

View the instructional tape/slide program: *Oscilloscope Orientation. Oscilloscope Amplitude and Frequency Measurement*, Div. of Continuing Publications, Portland State University.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL 2: **The student will be able to use the appropriate test equipment for measurement and evaluation of electronic circuits.**

COMPETENCIES: **The Student will be able to:**

2.8 use oscilloscope (lab).

2.9 use a tube tester.

PERFORMANCE INDICATORS:

2.8.1 Given a laboratory oscilloscope, the students will be able to set up and operate the lab scope available to them. They will be able to point out its special features to the satisfaction of the instructor. The operations will include voltage and time measurements and other measurements as directed by the instructor.

OPTIONAL

2.8.2 At the discretion of the instructor, the student may be asked to define or explain purpose of these lab scope features:

a. triggered sweep
b. sweep magnifier
c. bandwith and rise time
d. delayed presentation of waveform
e. dual trace vs. dual beam
f. storage scope
g. spectrum analyzer.

2.9.1 Given a tube checker and an assortment of tubes, the student will be able to determine whether a tube is suitable for use.

2.9.2 Given a tube checker, the student will be able to describe proper tube checking techniques.

2.9.3 Given any type of tube tester, emission or dynamic, the student will be able to evaluate its suitability for accurately testing tube characteristics.

SUGGESTED LEARNING ACTIVITIES:

Lab oscilloscope, Module EL-IO-08.

Testing tubes, Module EL-IO-10.

Demonstrate use of tube tester.

a. Demonstrate safety practices.
b. Read chart.
c. Use switches.
d. Insert tube.
e. Read meter.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL 2: **The student will be able to use the appropriate test equipment for measurement and evaluation of electronic circuits.**

COMPETENCIES: **The Student will be able to:**

2.10 use a transistor tester.

2.11 use a capacitor tester.

PERFORMANCE INDICATORS:

2.10.1 Given a selection of six to ten transistors, the student will be able to identify all defective transistors using an ohmmeter, within the capabilities of ohmmeter testing.

2.10.2 Given the same set of transistors and a commercial transistor tester, the student will be able to identify all defective transistors and specify what the defect is. The student will also be able to measure the beta of the good transistors.

OPTIONAL

2.10.3 If the equipment being used has the capability of testing field effect transistors (FET) and silicon controlled rectifiers (SCR), the student will also perform tests on a group of these devices to identify those that are defective.

2.11.1 Given a capacitor checker, the student will be able to read the value of capacitance from the scale provided within the reading error of the scale.

2.11.2 Given a capacitor checker and an assortment of capacitors, the student will be able to check them for value and leakage.

2.11.3 Given an electrolytic capacitor and a capacitor checker, the student will be able to determine the value, percent of power factor and leakage to within instrument accuracy.

SUGGESTED LEARNING ACTIVITIES:

Using a transistor tester, test several transistors, some known bad and some known good, to show varying indications.

Testing transistors, Module EL-IO-11.

Demonstrate use of capacitor checker.

a. Demonstrate safety practices.
b. Read capacitor value.
c. Check scale.
d. Set range.
e. Set test.
f. Connect capacitor.
g. Flip on-off switch.
h. Read meter.
i. Flip on-off switch.

Testing capacitors, Module EL-IO-12.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL 2: **The student will be able to use the appropriate test equipment for measurement and evaluation of electronic circuits.**

COMPETENCIES: The Student will be able to:

2.12 use an impedance bridge.

2.13 use an amprobe.

PERFORMANCE INDICATORS:

2.12.1 Given an impedance bridge (lab), the student will be able to identify the important controls.

2.12.2 Given an impedance bridge (lab), the student will be able to obtain a null balance.

2.12.3 Given a resistance of unknown value and an impedance bridge, the student will be able to obtain a resistance reading on an unknown resistor, accurate to three significant figures.

2.12.4 Given an inductance and capacitance, the student will be able to obtain the value of an inductance and capacitance reading on the impedance bridge.

2.13.1 Given a "clamp-on" ammeter, commonly called an amprobe, and a 220-volt single or three-phase system under load, the student will be able to measure the current in each leg of the system.

SUGGESTED LEARNING ACTIVITIES:

Bridge operations, Module EL-IO-13.

Measure current flow in a simple circuit with ammeter/amprobe.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 2: The student will be able to use the appropriate test equipment for measurement and evaluation of electronic circuits.

COMPETENCIES: The Student will be able to:

2.14 use a substitution box (resistance/capacitance)

2.15 use a frequency counter.

2.16 use a megger.

PERFORMANCE INDICATORS:

2.14.1 Given an R-C Combination Substitution Box, the student will be able to select a specific resistor, capacitor and capacitor/resistor network.

2.15.1 Given a frequency counter, the student will be able to set up and operate it to the satisfaction of the instructor. Operation of the instrument is to include three different frequency sources.

Have student check calibration in accordance with manual,
select proper input probes and cables,
read counter,
read unknown frequency. This requires proper switch placement and identification of unmeasurable frequency.

2.16.1 Given a megger, the student will be able to connect it to wire and determine whether it is shorted, open or has high resistance.

SUGGESTED LEARNING ACTIVITIES:

Have student remove front panel of R-C Box and draw schematic of instrument.

Have student measure values of components in the box.

Using a frequency counter and a DVM, demonstrate measurement of voltage and frequency.

Using a megger, demonstrate method of measuring three or more wires that have opens, shorts and high resistances.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL 2: The student will be able to use the appropriate test equipment for measurement and evaluation of electronic circuits.

COMPETENCIES: The Student will be able to:

2.17 use an isolation transformer (safety device).

2.18 use a growler.

PERFORMANCE INDICATORS:

2.17.1 Given an isolation transformer, the student will be able to isolate source ground from equipment ground.

2.18.1 Given a growler and an armature, the student will be able to determine the armature's condition.

SUGGESTED LEARNING ACTIVITIES:

Get student to identify locations in the lab where an isolation transformer would be necessary.

Demonstrate use of growler, using bad armature and good armature.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL 2: The student will be able to use the appropriate test equipment for measurement and evaluation of electronic circuits.

ASSEMBLY, MAINTENANCE AND REPAIR

COMPETENCIES: The Student will be able to:

3.1 use correct soldering techniques.

3.2 use proper desoldering techniques.

PERFORMANCE INDICATORS:

3.1.1 Given a variety of soldering tools, the student will be able to write conditions under which each would be used.

3.1.2 Given a variety of solder types, rosin core, acid core or silver, the student will be able to write conditions under which each would be used.

3.1.3 Given a variety of pre-made solder connections and an ohmmeter, the student will be able to segregate them into groups of properly and improperly executed connections.

3.1.4 Given twelve six-inch pieces of 20 AWG stranded hook-up wire, and the necessary soldering materials, the student will be able to correctly prepare those wires for connection.

3.1.5 Given terminals, printed circuit boards, copper tubing and switch lugs, the student will be able to solder these items to the instructor's satisfaction.

3.2.1 Given a variety of soldered connections, the student will be able to desolder each without any damage to the device.

SUGGESTED LEARNING ACTIVITIES:

Soldering, Module EL-RS-03.

Soft soldering, Module EL-RS-04.

View film: *On Solder*, 30 minutes, Classroom Film Distributors Inc., 5625 Hollywood, California.

View film: *The Art of Soldering*, Boeing Co. Public Relations, Seattle, Washington.

View: *Basic Soldering Skills*, 35 mm slides, Encyclopedia Britannica Films, Willamette, Illinois.

Demonstrate soldering techniques.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL 3: The student will be able to use appropriate electro-mechanical, construction, installation, maintenance and repair techniques on electrical/electronic/mechanical equipment.

COMPETENCIES: The Student will be able to:

3.3 properly use hand tools.

3.4 use a micrometer.

PERFORMANCE INDICATORS:

3.3.1 Given 20 hand tools, the student will be able to correctly list the names of all 20 tools.

3.3.2 Given a list of 20 hand tools, the student will be able to write the correct use for each.

3.3.3 Given a list of tasks and a kit of electrical hand tools, the student will be able to execute those tasks to the instructor's satisfaction.

3.3.4 Given an assortment of hand tools such as a screwdriver, cold chisel and center punch, the student will be able to dress them to the instructor's satisfaction.

3.4.1 Given a micrometer, the student will be able to identify and list the basic parts of the micrometer.

3.4.2 Given a micrometer and ten items of varying thickness, the student will be able to measure the items with an error of no more than .001 inch.

SUGGESTED LEARNING ACTIVITIES:

The care, proper use and application of tools should be covered throughout the course. An orientation should be given before the initial use.

Use Flash Cards for tool identification.

Demonstrate use of hand tools.

Hand tools, Module EL-RS-07.

Electrical special tools, Module EL-RS-06.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL 3: The student will be able to use appropriate electro-mechanical, construction, installation, maintenance and repair techniques on electrical/electronic/mechanical equipment.

COMPETENCIES: The Student will be able to:

3.5 use an electric hand drill & drill press.

3.6 use wire wrapping equipment.

3.7 use a brake (sheet metal).

PERFORMANCE INDICATORS:

3.5.1 Given a drill press and a task, the student will be able to perform that task while observing all required safety precautions.

3.6.1 (Generate your own performance indicators)

3.7.1 (Generate your own performance indicators)

SUGGESTED LEARNING ACTIVITIES:

Drill press operations, Module EL-RS-08.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 3: The student will be able to use appropriate electro-mechanical, construction, installation, maintenance and repair techniques on electrical/electronic/mechanical equipment.

COMPETENCIES: The Student will be able to:

3.8 use a power threader.

3.9 use a grinding wheel.

3.10 use a lathe and milling equipment.

PERFORMANCE INDICATORS:

3.8.1 (Generate your own performance indicators)

3.9.1 Given a work sheet and tools, the student will be able to dress a grinding wheel to the instructor's satisfaction.

3.10.1 (Generate your own performance indicators)

SUGGESTED LEARNING ACTIVITIES:

Demonstrate care, proper use and application of power tools in the shop. These should be covered periodically throughout the course.

View films on safety/power tools. Film available from local IED or Oregon State Compensation Board.

Hand grinding wheel, Module EL-RS-10.

Demonstrate use of bench lathe.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 3: The student will be able to use appropriate electro-mechanical, construction, installation, maintenance and repair techniques on electrical/electronic/mechanical equipment.

COMPETENCIES: The Student will be able to:

3.11 use a sabre saw.
3.12 use a stud gun.
3.13 use a vacuum pump.
3.14 use a bearing puller and installer.

PERFORMANCE INDICATORS:

3.11.1 (Generate your own performance indicators)

3.12.1 (Generate your own performance indicators)

3.13.1 (Generate your own performance indicators)

3.14.1 (Generate your own performance indicators)

SUGGESTED LEARNING ACTIVITIES:

Demonstrate use of stud gun.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 3: The student will be able to use appropriate electro-mechanical, construction, installation, maintenance and repair techniques on electrical/electronic/mechanical equipment.

COMPETENCIES: The Student will be able to:

3.15 perform power tool maintenance.

PERFORMANCE INDICATORS:

3.15.1 Given a list of the common power hand tools, the student will be able to identify the common problems associated with each one and check for those problems.

3.15.2 Given a power hand tool with a brush type motor, the student will be able to test the armature and field coils and test and fit brushes.

3.15.3 Given a power hand tool commutator and a commutator lathe, the student will be able to turn, clean and put a finish on the commutator.

3.15.4 Given a power hand tool, the student will be able to remove and replace the sleeve and ball bearings and use the correct lubricant.

SUGGESTED LEARNING ACTIVITIES:

Small power tool maintenance, Module EL-EM-13.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 3: The student will be able to use appropriate electro-mechanical, construction, installation, maintenance and repair techniques on electrical/electronic/mechanical equipment.

COMPETENCIES: The Student will be able to:

3.16 use a pipe bender "hickey."

3.17 use flaring tools.

3.18 use cutting and threading tools.

PERFORMANCE INDICATORS:

3.16.1 Given a 1/2" rigid conduit bender, called a "hickey," a piece of 1/2" rigid conduit, 2 – 4/s boxes, 4 – 1/2" lock nuts, 2 – 1/2" common bushings, a hack saw, a pipe vise, a 1/2" pipe die, and cutting oil, the student will be able to connect the two 4/s boxes with rigid conduit in accordance with instructions.

3.16.2 Given an EMT bender and a piece of 1/2" EMT, 2 – 4/s boxes, 2 – 1/2" EMT connectors and a hack saw, the student will be able to connect the two boxes with the EMT according to instructions.

3.17.1 Given an assortment of commonly used conduits and fittings, and an information sheet, the student will be able to identify the conduits and fittings and relate them to each other.

3.18.1 Given a pipe vise and a set of pipe dies, the student will be able to identify each by its size.

3.18.2 Given an assortment of metal drill bits, a set of taps, a tap wrench, an electric drill and a piece of metal 1/8" thick, the student will be able to drill and tap holes for various size machine screws.

SUGGESTED LEARNING ACTIVITIES:

Identify, cut, and bend EMT and rigid conduit.

Demonstrate threading rigid conduit.

Electro-mechanical safety module, EL-RS-19.

Identify, cut, bend and flare tubing.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 3: The student will be able to use appropriate electro-mechanical, construction, installation, maintenance and repair techniques on electrical/electronic/mechanical equipment.

COMPETENCIES: The Student will be able to:

3.19 install an electric service.

3.20 install boxes and panels.

3.21 install conduit, cables, raceways and fittings.

PERFORMANCE INDICATORS:

3.19.1 Given 100A distribution box, circuit breakers and a meter base and an information sheet, the student will be able to assemble the material for a complete 100-ampere service.

3.19.2 Given an information sheet, the student will be able to compute the service load for a house having loads, in addition to the small appliance, laundry and lighting loads. The student will also be able to define "demand factor" and discuss when used.

3.20.1 Given an assortment of outlet boxes, the student will be able to identify all of the boxes by their trade names.

3.20.2 Given a set of knockout punches, commonly called KO punches, a metal junction box, a 5/8" drill bit, a 1/2" electric drill and a crescent wrench, the student will be able to cut a hole of a given size in the junction box.

3.21.1 Given a set of hole saws, a 1/2" electric drill, and a metal junction box, the student will be able to saw a given size hole in the junction box.

SUGGESTED LEARNING ACTIVITIES:

Have student read the pamphlet: *Industrial Electronics*, Sutton Publishing Co., Inc., 172 S. Broadway, White Plains, New York.

View the film: *The Electrician*, Missouri University, 10 minutes.

Schematics, diagram and layouts, Module EL-RS-24.

Housewiring, Module EL-RS-15.

Demonstrate wiring on frames or simulator.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 3: **The student will be able to use appropriate electro-mechanical, construction, installation, maintenance and repair techniques on electrical/electronic/mechanical equipment.**

COMPETENCIES: The Student will be able to:

3.22 install/connect grounding devices.

3.23 install/connect fixtures and appliances.

3.24 use wire pulling equipment.

PERFORMANCE INDICATORS:

3.22.1 Given an assortment of outlet boxes, wiring devices, wire, wire connectors, tools, a bread board and a diagram, the student will be able to assemble these components in accordance with the diagram.

3.23.1 Given wire of various sizes, electrical tape, an electrician's knife, the necessary wrenches and pliers, solder, soldering paste and a butane torch, the student will be able to make up the commonly used splices in accordance with instructions.

3.23.2 Given any task requiring the use of electrical conductors and a list of conductors available, the student will be able to select the proper conductor for the task. The proper conductor will be determined by its electrical characteristics.

3.24.1 Given an electrician's "fish" tape and instructions, the student will be able to demonstrate to the instructor the proper use of the fish tape.

SUGGESTED LEARNING ACTIVITIES:

Electrical wiring skills, Module EL-RS-11.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL:3: **The student will be able to use appropriate electro-mechanical, construction, installation, maintenance and repair techniques on electrical/electronic/mechanical equipment.**

COMPETENCIES: The Student will be able to:

3.25 identify wire and cable by size and color code.

3.26 form cable harnesses.

3.27 lace/strap wire.

PERFORMANCE INDICATORS:

3.25.1 Given an assortment of commonly used wire and cables, the student will be able to identify each wire or cable by its trade name.

3.25.2 Given an assortment of wiring devices, the student will be able to identify each device by its trade name.

3.26.1 Given a harness wiring band and wire, the student will be able to manufacture an acceptable harness.

3.27.1 Given twenty-five pieces of 20 AWG stranded hook-up wire, twenty-four inches long, and the necessary spot-tie, the student will be able to correctly unite those wires into a cable.

SUGGESTED LEARNING ACTIVITIES:

Wire type identification, Module EL-RS-07.

Measure wire sizes using wire gauge and micrometer.

Have student manufacture terminal boards and use them for wiring practice.

Component mounting, Module EL-RS-22.

Electronic wiring skills, Module EL-RS-20.

Have student study the textbook: *Electronics Assembly Methods and Fabrication*, Duarte and Duarte, McGraw-Hill.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 3: The student will be able to use appropriate electro-mechanical, construction, installation, maintenance and repair techniques on electrical/electronic/mechanical equipment.

COMPETENCIES: The Student will be able to:

3.28 connect wire to terminals.

3.29 prepare and connect cables and wires.

3.30 cut/strip/splice wire and cable.

PERFORMANCE INDICATORS:

3.28.1 Given a pre-laced section of wire bundle and a premounted terminal strip, the student will be able to correctly fan out one end of the cable and connect the individual wires to preassigned terminals on the terminal strip.

3.29.1 Given an electronic subassembly, a wiring diagram, a VOM and the necessary wire and soldering materials, the student will be able to wire the subassembly and make a point-to-point continuity check.

3.29.2 Given an electronic assembly rack, a wiring diagram, a VOM and the necessary soldering material, the student will be able to wire that rack and perform a point-to-point continuity check.

3.30.1 (Generate your own performance indicators)

SUGGESTED LEARNING ACTIVITIES:

Dissassemble and assemble equipment. Cut strip wire.

Demonstration: Lace wire with waxed twine.

View film: *Wire Sizes and Voltage Drop*, United World Films, Inc., 1445 Park Avenue, New York, N.Y. 10029 (or available at the University of Illinois).

Demonstration: Cut, strip and splice wire.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 3: The student will be able to use appropriate electro-mechanical, construction, installation, maintenance and repair techniques on electrical/electronic/mechanical equipment.

COMPETENCIES: The Student will be able to:

3.31 identify electronic parts and components.

3.32 assemble, install, and connect switches, transformers, capacitors, subassemblies, etc.

PERFORMANCE INDICATORS:

3.31.1 Given a variety of component types (resistors, capacitors, inductors, transistors, integrated circuits) with each component of the same type having different physical characteristics, the student will be able to identify them.

3.31.2 Given the conditions for the use of any type component, the student will be able to select the component package whose physical characteristics best fit the stated conditions.

3.32.1 Given a variety of mechanically mounted components such as power transistors, zener diodes, potentiometers, filter capacitors and a suitable mounting surface, the student will be able to correctly mount the components in a workmanlike manner.

3.32.2 Given 12 axial-lead components such as resistors and capacitors, seven bifurcated terminals, seven turret terminals and the necessary soldering materials, the student will be able to mount those components correctly between two terminals in a workmanlike manner.

3.32.3 Given a TO-5 10-lead integrated circuit, four components such as resistors and capacitors, two components with axial leads and two with radial leads, an etched and drilled circuit board, and the necessary soldering materials, the student will be able to mount those componenets correctly on the circuit board in a workmanlike manner.

SUGGESTED LEARNING ACTIVITIES:

Have student assemble, repair, and install electrical/mechanical devices and equipment.

Component packaging, Module EL-RS-21.

Component mounting, Module EL-RS-22.

Demonstrate installation of electro-mechanical equipment, using test equipment and applying all rules of safety.

Have students check grounding of all electrical equipment at their work stations.

View film: *Grounding High Voltage*, A. B. Chance Co.

View film: *Circuit Breakers*, Westinghouse, 10 minutes (free).

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 3: **The student will be able to use appropriate electro-mechanical, construction, installation, maintenance and repair techniques on electrical/electronic/mechanical equipment.**

COMPETENCIES: The Student will be able to:

3.33 construct chassis.

3.34 use fastening devices (screws, bolts, rivets).

PERFORMANCE INDICATORS:

3.33.1 Given one or two electronic subassemblies and required interface wiring, the student will be able to draw a chassis construction plan. The plan must describe a chassis that will provide a safe and secure enclosure for the subassemblies.

3.33.2 Given a chassis construction plan, required shear and brakes and sheet metal, the student will be able to build a chassis. The chassis must conform to the layout drawing within 1/16".

3.33.3 Using the completed chassis and given a completed subassembly, the student will be able to install the subassembly in the chassis. The result must be a safe and secure method of holding and enclosing the subassembly.

3.34.1 Given metal screws, nuts, bolts and rivets, the student will be able to demonstrate how each item fastens and holds.

SUGGESTED LEARNING ACTIVITIES:

Chassis construction, Module EL-RS-06.

Demonstrate use of shear, brake and other metal working tools involved with chassis manufacture.

Demonstrate various methods of fastening; i.e., screws, bolts, rivets, pop-rivets and the associated tools.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 3: The student will be able to use appropriate electro-mechanical, construction, installation, maintenance and repair techniques on electrical/electronic/mechanical equipment.

COMPETENCIES: The Student will be able to:

3.35 inspect/replace protective and control devices (fumes, thermal switches, relays, timers, etc.).

3.36 troubleshoot a series circuit.

PERFORMANCE INDICATORS:

3.35.1 Given a fuse and a circuit, the student will be able to properly fuse the circuit within the safety limits of the conductor.

3.35.2 Given a circuit breaker and circuit, the student will be able to properly protect the circuit within the safety limits of the conductor.

3.35.3 Given a group of fuses and circuit breakers, the student will be able to identify and describe the uses of each.

3.35.4 Given a fluid control valve, the student will be able to demonstrate his understanding of fluid control valves and their application.

3.35.5 Given an electro-mechanical time switch, program chart and VOM, the student will be able to determine if it is defective or functioning normally.

3.35.6 Given a defective time switch and VOM, the student will be able to determine whether complete replacement or repair of the switch is indicated.

3.36.1 Given a series circuit, the student will be able to analyze the circuit for proper operation.

3.36.2 Given an inoperative series circuit, the student will be able to repair the circuit and restore it to proper operation.

SUGGESTED LEARNING ACTIVITIES:

Electrical safety devices, Module EL-RS-16.
Fluid controls, Module EL-EM-04.
Temperature sensors, Module EL-EM-05.
Synchro systems, Module EL-EM-06.
Motor controls, Module EL-EM-07.

Troubleshooting the series circuit, Module EL-RS-17.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 3: The student will be able to use appropriate electro-mechanical, construction, installation, maintenance and repair techniques on electrical/electronic/mechanical equipment.

COMPETENCIES: The Student will be able to:

3.37 troubleshoot a parallel circuit.

PERFORMANCE INDICATORS:

3.37.1 Given a parallel circuit, the student will be able to analyze the circuit for proper operation.

3.37.2 Given a malfunctioning parallel circuit, the student will be able to repair and restore the circuit to proper operation.

SUGGESTED LEARNING ACTIVITIES:

Troubleshooting the parallel circuit, Module EL-RS-18.

Fundamentals of troubleshooting, Module EL-DR-01.

Read the pamphlet: *Instruments and Apparatus News*. It can be ordered by writing to 845 Ridge Avenue, Pittsburgh, Pennsylvania.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 3: The student will be able to use appropriate electro-mechanical, construction, installation, maintenance and repair techniques on electrical/electronic/mechanical equipment.

COMPETENCIES: The Student will be able to:

3.38 maintain electrical/mechanical systems.

PERFORMANCE INDICATORS:

3.38.1 Given the appropriate materials, the student will be able to outline basic troubleshooting procedures in proper sequence for locating a specific trouble.

3.38.2 Given a piece of equipment and a statement of its operating condition, the student will be able to find the parts or areas that show defects by using his/her senses.

3.38.3 Given a piece of equipment with a specific trouble and the necessary parts, the student will be able to repair the equipment and return it to proper operating condition.

3.38.4 Given a defective part, the student will be able to prepare an order to replace the part.

3.38.5 The student will be able to test each electrical component using either a test lamp, a voltmeter, or an ohmmeter.

3.38.6 Given a wiring diagram, the student will be able to trace all circuits from the timer to each electrically operated unit.

3.38.7 Given a device that involves mechanical operation and a statement of its working conditions, the student will be able to locate the problems using the tools and equipment required.

3.38.8 Given a mechanical device, the student will be able to diagnose trouble and make repair estimates.

SUGGESTED LEARNING ACTIVITIES:

Have student study EL-DR-02 on electrical troubleshooting.

Have student study EL-DR-03 on mechanical troubleshooting.

An initial orientation should be given the student regarding the cleaning of parts and equipment. The student should apply these procedures and concepts during the course:

cleaning,
inspecting,
testing,
calibrating,
lubricating,
disassembling/reassembling,
determining repairability,
maintaining logs and records,
troubleshooting,
making safety inspections,
replacing defective components.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 3: The student will be able to use appropriate electro-mechanical, construction, installation, maintenance and repair techniques on electrical/electronic/mechanical equipment.

COMPETENCIES: The Student will be able to:

3.39 adjust/repair small household appliances.

PERFORMANCE INDICATORS:

3.39.1 Given a list of small household appliances, for example, toasters, mixers and blenders, the student will be able to describe how to make simple or minor adjustments and repairs.

3.39.2 Given a list of small household appliances, the student will be able to list the most common problems and the probable cause of those problems.

SUGGESTED LEARNING ACTIVITIES:

Small household appliances, Module EL-EM-12.

Demonstrate actual application of belts and pulleys.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 3: The student will be able to use appropriate electro-mechanical, construction, installation, maintenance and repair techniques on electrical/electronic/mechanical equipment.

COMPETENCIES: The Student will be able to:

3.40 inspect/replace/repair motors, generators, servos, etc.

PERFORMANCE INDICATORS:

3.40.1 Given a size "O" magnetic motor starter (mag) and a wiring diagram, the student will be able to identify the components of the starter and tell the instructor their functions.

3.40.2 Given a stop-start switch and a wiring diagram, the student will be able to identify the components and tell the instructor their functions.

3.40.3 Given a magnetic motor starter, a stop-start switch, a single phase motor, the necessary wire and tools, the student will be able to connect these components in accordance with the diagram.

3.40.4 Given two stop-start switches, one magnetic motor starter, a single phase motor, the necessary wire and tools, the student will be able to connect the components in accordance with the diagram.

3.40.5 Given a reversing swtich (pushbutton type), a reversing mag, a single phase motor, the necessary tools and wire, the student will be able to connect the components in accordance with the diagram.

3.40.6 Given a washing machine, the student will be able to demonstrate his/her understanding of the principles of operation of torque motors, solenoids and electrical clutches and brakes.

3.40.7 Given a selection of five common belts, the student will be able to list three common types of belts.

SUGGESTED LEARNING ACTIVITIES:

DC generators, Module EL-BC-32.
Alternators, Module EL-BC-33.
DC motors, Module EL-BC-34.
AC motors, Module EL-BC-35.

Inspect and replace bearings, gears, pulleys, etc., for demonstration.

Measure bearings and check bearing clearances using micrometers, dial indicators, and plastic gauges as applied to specific types of bearings.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 3: The student will be able to use appropriate electro-mechanical, construction, installation, maintenance and repair techniques on electrical/electronic/mechanical equipment.

COMPETENCIES: The Student will be able to:

3.40 inspect/replace/repair motors, generators, servos, etc.

PERFORMANCE INDICATORS:

OPTIONAL

3.40.8 Given samples of three common types of belts, the student will be able to name them and tell where they might be used.

The student will be able to state the advantages and disadvantages of belt drive systems.

Given a belt drive system, the student will be able to identify its parts.

Given a belt drive, the student will be able to:

a. safely change the belt
b. align the belt
c. adjust tension, keeping it so that the bearings are not damaged
d. point out what to look for in examining a belt for wear.

SUGGESTED LEARNING ACTIVITIES:

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 3: The student will be able to use appropriate electro-mechanical, construction, installation, maintenance and repair techniques on electrical/electronic/mechanical equipment.

COMPETENCIES: The Student will be able to:

3.41 repair refrigeration systems.

PERFORMANCE INDICATORS:

3.41.1 Given a basic refrigeration unit with a gas leak, the student will be able to locate the leak, repair the leak, pull a vacuum on the system and recharge the system.

3.41.2 Given the components that make up a basic refrigeration system, the student will assemble the components in their proper order, pull a vacuum on the system, check for leaks and charge the system according to instructions, using the tools and equipment available in the shop.

3.41.3 Given a refrigeration unit with a mechanical problem and the necessary tools, the student will be able to determine the problem and repair it satisfactorily.

3.41.4 Given a refrigeration unit with an electrical problem, the student will be able to determine the problem and make necessary repairs.

SUGGESTED LEARNING ACTIVITIES:

Refrigeration troubleshooting, Module EL-DR-04.

Refrigeration mechanical repair, Module EL-DR-05.

Inspect and install seals, hoses, pumps, etc., as a demonstration.

Instructor and student will demonstrate and discuss the following:

inspection and installation of grounding,
inspection of equipment for wear/malfunctioning,
following blueprints,
assembling electronic devices,
maintenance of systems,
following manufacturers' specifications,
layout
amprobe,
adjusting, calibrating equipment,
circuit changes,
assemble experimental circuitry.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 3: The student will be able to use appropriate electro-mechanical, construction, installation, maintenance and repair techniques on electrical/electronic/mechanical equipment.

COMPETENCIES: The Student will be able to:

3.42 repair washing machines and dryers.

PERFORMANCE INDICATORS:

3.42.1 Given an automatic washing machine, the student will be able to identify all electrical components in the electrical system.

3.42.2 Given a parts catalog, the student will be able to identify the major mechanical units and parts of an automatic washing machine.

3.42.3 Given an automatic washing machine, the student will be able to make an operations check to be sure the machine is operating properly.

3.42.4 Given a machine with a faulty unit, the student will be able to diagnose the trouble, repair or replace the unit in question.

3.42.5 Given a repair manual, the student will be able to completely disassemble an automatic washing machine, check units for wear, replace faulty units, and reassemble the machine in the proper sequence.

3.42.6 Given an inoperative clothes dryer, the student will be able to trace the electro/mechanical circuitry to determine the problem.

SUGGESTED LEARNING ACTIVITIES:

Discuss preventative maintenance of seals.

Automatic washing machines, mechanical, Module EL-EM-10.

Automatic washing machines, electrical, Module EL-EM-11.

Dismantle and investigate washing machines, dryers and machine shop equipment.

Clothes dryers, mechanical, Module EL-EM-08.

Clothes dryers, electrical, Module EL-EM-09.

Washing machines, mechanical, Module EL-EM-10.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 3: **The student will be able to use appropriate electro-mechanical, construction, installation, maintenance and repair techniques on electrical/electronic/mechanical equipment.**

ELECTRICAL/ELECTRONIC THEORY AND MATH

COMPETENCIES: **The Student will be able to:**

4.1 explain the electron theory.

PERFORMANCE INDICATORS:

4.1.1 Given instruction in Newton's four basic laws and writing materials, the student will be able to write correctly Newton's four basic laws of physics.

4.1.2 Given instruction in Newton's laws and the atom, the student will be able to explain, in writing, Newton's four basic laws of physics as they apply to the atom.

4.1.3 Given instruction in the structure of the atom, the student will be able to describe, in writing, the structure of the atom that makes up electron flow.

SUGGESTED LEARNING ACTIVITIES:

Demonstrate static charges using electroscope and pith ball.

View film: *Principles of Electricty*, General Electric Co., 1 River Road, Schenectady, N.Y., 20 minutes.

View film: *Basic Electricty*, Almanac, free loan. (The address for this and other film distributors is found in Appendix on Media.)

View instructional tape/slide program: *What Is Electricty?*, Division of Continuing Publications, Portland State Univeristy.

Atomic theory, Module EL-BC-01.

View film: *A is for Atom*, Atomic Energy Commission, free.

SUGGESTED TOPICS: (For your own use)

COMPETENCIES: The Student will be able to:

4.2 explain voltage.

PERFORMANCE INDICATORS:

4.2.1 Given resource materials on energy and writing materials, the student will be able to write correctly the difference between kinetic and potential energy.

4.2.2 Given resource materials on potential energy and writing material, the student will be able to define, in writing, an electrical difference of potential.

4.2.3 Given resource materials on electromotive force and writing materials, the student will be able to state, in writing, the prime methods of generating electromotive force (EMF).

4.2.4 Given a voltmeter, a source and a simple electrical circuit, the student will be able to correctly complete a voltage measurement.

SUGGESTED LEARNING ACTIVITIES:

Have students construct a chemical cell and measure potential difference with meter.

View film: *Battery Electricity*, University of Illinois, 11 minutes, rental.

View film: *Amperes, Volts & Ohms,* TAI, 10 minutes, rental.

View Film: *Current & Electromotive Force*, U.S. Navy, free.

Voltage, Module EL-BC-02.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL 4: The student will be able to use basic electrical/electronic theory and related mathematics.

COMPETENCIES: The Student will be able to:

4.3 explain current and resistance.

PERFORMANCE INDICATORS:

4.3.1 The student will be able to define, in writing, the term "current."

4.3.2 The student will be able to define, in writing, the term "resistance."

4.3.3 The student will be able to describe, in writing, the relationship that exists between current and resistance.

4.3.4 The student will be able to define, in writing, the term "conductance."

4.3.5 The student will be able to state, in writing, the characteristic that determines whether a material is a conductor, semiconductor or insulator.

4.3.6 The student will be able to define, in writing, the term "ampere."

4.3.7 The student will be able to define, in writing, the term "ohm."

SUGGESTED LEARNING ACTIVITIES:

Discuss the resistance analogy: Bend water hose which has water flowing through it. Emphasis at this point, should be made that analogy does not apply to AC.

Current and resistance, Module EL-BC-03.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL 4: The student will be able to use basic electrical/electronic theory and related mathematics.

COMPETENCIES: The Student will be able to:

4.4 explain conductors, insulators and semiconductors.

PERFORMANCE INDICATORS:

4.4.1 Given an ohmmeter, the student will be able to perform a continuity check to identify conductors, insulators and semiconductors.

4.4.2 The student will be able to explain the difference in atomic structure of conductors, insulators and semiconductors.

4.4.3 The student will be able to explain how semiconductors are caused to conduct electricity.

4.4.4 The student will be able to explain covalent bonding.

4.4.5 The student will be able to explain hole flow and electron flow in a semiconductor.

SUGGESTED LEARNING ACTIVITIES:

Study the film: *Conductors and Semiconductors*, LTD, free.

Conductors, semiconductors and insulators, Module EL-BC-04.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 4: The student will be able to use basic electrical/electronic theory and related mathematics.

COMPETENCIES: The Student will be able to:

4.5 explain Omm's Law.

PERFORMANCE INDICATORS:

4.5.1 Given Ohm's Law the student will be able to write the relationship between current and voltage, and current and resistance as expressed in Ohm's Law.

4.5.2 Given the symbols for current, voltage and resistance, the student will be able to write the three mathematical expressions of Ohm's Law.

4.5.3 Given specific values of two of the three quantities in Ohm's Law, the student will be able to solve for the unknown third.

4.5.4 Given the necessary resistor, voltage source, voltmeter and ammeter, the student will, in 30 minutes be able to construct a circuit and make the necessary measurements to verify, within $\pm$ 10%, the accuracy of any circuit calculations they have made.

SUGGESTED LEARNING ACTIVITIES:

Have student experimentally confirm Ohm's Law.

View film: *Using Ohm's Law to Understand Circuits*, MSU, 15 minutes, rental.

View film: *Ohm's Law*, TAI, 19 minutes, rental.

Ohm's Law, Module EL-BC-05.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: **4: The student will be able to use basic electrical/electronic theory and related mathematics.**

COMPETENCIES: **The Student will be able to:**

4.6 explain Watt's Law.

4.7 explain series resistive circuits.

PERFORMANCE INDICATORS:

4.6.1 The student will be able to write the relationship between power, current and voltage.

4.6.2 Given the symbols for power, current and voltage, the student will be able to write the three mathematical expressions of Watt's Law.

4.6.3 Given four carbon resistors of different wattage rating, the student will be able to identify the wattage rating of each.

4.6.4 Given specific values for two of the three quantities in Ohm's Law, the student will be able to solve for power.

4.6.5 Given two of the three values of input power, output power and efficiency, the student will be able to compute the third.

4.7.1 Give the appropriate symbols and terms, the student will be able to write the basic rules and the mathematical expressions (formulas) which pertain to the series circuit, its current, its voltage, its resistance and its power.

4.7.2 Given a series circuit consisting of two or more resistors containing sufficient known values for solution, the student will be able to apply the basic rules of a series circuit with Ohm's Law and Watt's Law to solve the circuit for the unknown values.

SUGGESTED LEARNING ACTIVITIES:

Show effects of power dissipation through heat being given off from components.

View film: *Watts, Watthours & Watthour Meters*, MSU, 15 minute, rental.

Watt's Law, Module EL-BC-06.

Series resistive circuits, Module EL-BC-07.

Have student experimentally prove his/her mathematical computations regarding DC series circuits.

Have student wire circuit and measure current as variable resistor is increased and decreased.

Have student wire circuit and measure current as variable voltage supply is increased and decreased.

Have student wire batteries in series adding and series opposing and analyze effects.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: **4: The student will be able to use basic electrical/electronic theory and related mathematics.**

COMPETENCIES: The Student will be able to:

4.8 explain the voltage divider.

4.9 explain parallel resistive circuits.

PERFORMANCE INDICATORS:

4.8.1 Given a circuit diagram or written circuit requirements of a voltage divider with two or more output taps and load resistors connected from any or all of the taps to common, the student will be able to correctly calculate all load voltages when given the source voltage divider resistance values and load resistance values.

4.8.2 Given a circuit and lab equipment, the student will verify the computations in a laboratory experiment to within instrument accuracy in either an operational circuit or a circuit assigned.

4.9.1 Given a list of circuit characteristics, the student will be able to select two basic characteristics of a parallel circuit.

4.9.2 Given a list of circuit relationships, the student will be able to state the relationship between the applied voltage and the voltage across the individual branches in a parallel circuit.

4.9.3 Given the circuit parameters, the student will be able to compute the individual branch current and total current in a parallel circuit.

4.9.4 Given any number of parallel resistances, the student will be able to correctly calculate the equivalent (total) conductance and resistance of the parallel circuit.

4.9.5 Given any number of parallel resistances, the student will be able to compute power dissipation in parallel circuits.

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SUGGESTED LEARNING ACTIVITIES:

Voltage dividers, Module EL-CT-05.

Have the student wire batteries in parallel and analyze effect of voltage and current as additional batteries are connected to circuit.

Have student experimentally confirm mathematical calculations with resistors in parallel.

Parallel resistive circuits, Module EL-BC-08.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 4: The student will be able to use basic electrical/electronic theory and related mathematics.

COMPETENCIES: The Student will be able to:

4.10 explain series-parallel resistive circuits.

PERFORMANCE INDICATORS:

4.10.1 Given a set of series-parallel combinations, the student will determine the resistance equivalent of each.

4.10.2 Given a circuit diagram of series-parallel networks consisting of a voltage source, the student will calculate the correct current values.

4.10.3 Given a schematic diagram, the student will determine voltage at various points along a circuit.

4.10.4 Given a schematic of a series-parallel network, the student will verify circuit computations with proper laboratory test equipment.

4.10.5 Given a set of parameters, the student will be able to calculate power dissipation in a series-parallel circuit.

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SUGGESTED LEARNING ACTIVITIES:

View film: *Series and Parallel Circuits,* TAI, rental, 10 min.

Have student experimentally prove his/her mathematical computations regarding DC Series-Parallel circuits.

Series parallel resistive circuits, Module EL-BC-09.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL 4: The student will be able to use basic electrical/electronic theory and related mathematics.

COMPETENCIES: The Student will be able to:

4.11 explain Kirchoff's laws.

PERFORMANCE INDICATORS:

4.11.1 Given the basic rules for electrical circuits, the student will be able to state Kirchoff's laws for current and voltage.

4.11.2 Given circuit diagrams, the student will be able to solve correctly all circuit values using Kirchoff's Voltage Law.

4.11.3 Given proper schematic diagrams, the student will be able to apply Kirchoff's current law to complex networks.

4.11.4 Given a schematic diagram, the student will be able to set up a loop equation and assign polarities.

4.11.5 Given Kirchoff's loop equations, the student will be able to calculate given circuit values from schematics which have two EMF sources.

SUGGESTED LEARNING ACTIVITIES:

Kirchoff's Law, Module EL-BC-10.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL 4: **The student will be able to use basic electrical/electronic theory and related mathematics.**

COMPETENCIES: The Student will be able to:

4.12 explain magnets and magnetic fields.

PERFORMANCE INDICATORS:

4.12.1 Given pieces of iron, steel, cobalt and nickel, the student will be able to demonstrate that they can be magnetized.

4.12.2 Given an electromagnet and magnets with different pole strength, the student will be able to explain and demonstrate how magnetic force changes as the strength of the poles varies and as distance between the poles change.

4.12.3 Given a compass, tacks, a permanent or an electromagnet, and sheets of various kinds of materials, the student will be able to demonstrate magnetic transparency.

4.12.4 Given a compass, tacks, a permanent or an electromagnet and sheets of various kinds of materials, the student will be able to demonstrate magnetic permeability.

SUGGESTED LEARNING ACTIVITIES:

Experiment with various materials to determine magnetic effects.

Check magnetic field with compass.

View film: *Magnetic Effects of Electricity*, University of Illinois, 14 minutes, rental.

Magnetic fields, Module EL-BC-12.

View film: *Magetism*, Coronet, 11 minutes, rental.

Magnets, Module EL-BC-11.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 4: The student will be able to use basic electrical/electronic theory and related mathematics.

COMPETENCIES: The Student will be able to:

4.13 explain AC terminology.

PERFORMANCE INDICATORS:

4.13.1 Given the physical parameters of the terrain the student will be able to explain how alternating current is generated and how it is transmitted from point of generation to point of consumption.

4.13.2 Given a circuit diagram, the student will be able to diagram the current flow in an alternating current circuit.

4.13.3 Given a transformer, the student will be able to explain the purpose of a transformer in an AC power transmission circuit.

4.13.4 Given a paper and pencil, the student will be able to write the power loss formula.

4.13.5 Given a paper and pencil, the student will be able to write the voltage current equation for electric power.

4.13.6 Given a generator, the student will be able to explain how generators produce an alternating current.

4.13.7 Given a graph and mockup equipment, the student will be able to describe the development of the alternating current waveform.

4.13.8 Given graph paper, the student will be able to project a sine wave onto a graph indicating polarities and degrees of rotation.

4.13.9 Given graph paper and pencil, the student will be able to draw sine waves of different frequencies and write their equation with respect to time.

SUGGESTED LEARNING ACTIVITIES:

Take a field trip to the Bonneville Dam Power House.

Take a field trip to B.P.A. Test Facility, Ross Sub Area, Vancouver, WA.

AC Terminology, Module EL-BC-13.

Study the filmstrip: *Alternating Current*, 50 frames, USAF/United World Films, Inc., 1445 Park Avenue, N.Y. 10029.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL 4: The student will be able to use basic electrical/electronic theory and related mathematics.

COMPETENCIES: The Student will be able to:

4.13 explain AC terminology. (continued)

4.14 define and calculate sine wave values.

4.15 calculate AC power.

PERFORMANCE INDICATORS:

4.13.10 Given equations, the student will be able to express in writing the different values of alternating currents and voltages.

4.14.1 Given the term "Alternating Current," frequency and cycles, the student will be able to define each orally or in writing.

4.14.2 Given the term AC, the student will be able to define the following terms: peak to peak, peak, effective or RMS and average value, as it pertains to the AC wave form.

4.14.3 Given a value of average, effective, peak or peak to peak voltage, the student will be able to convert from one value to another.

4.15.1 Given an AC circuit and its operating conditions, the student will be able to calculate apparent power, real power and reactive power.

4.15.2 Given the mathematical equations, the student will be able to make the necessary calculations to determine the value for L or C which when added to a circuit will make the power factor unity.

SUGGESTED LEARNING ACTIVITIES:

Sine wave generation, Module EL-BC-14.

View film: *Inductance*, Allis Chalmers, free.

Inductance, Module EL-BC-15.

View film: *Inductance*, University of Illinois, 33 minutes.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL 4: The student will be able to use basic electrical/electronic theory and related mathematics.

COMPETENCIES: The Student will be able to:

4.16 explain and calculate inductance.

PERFORMANCE INDICATORS:

4.16.1 Given a list of symbols, the student will be able to define inductance and identify correctly inductance symbols.

4.16.2 Given an inductor, the student will be able to define and describe "self-inductance" and give at least two examples of applications.

4.16.3 Given a transformer, the student will be able to define and describe "mutual inductance" and give at least two examples of applications.

4.16.4 Given an inductor and a source of voltage, the student will be able to calculate the self-induced voltages of an inductor.

4.16.5 Given an inductor, the student will state and identify three out of the four factors which affect the inductance of a coil.

4.16.6 Given the correct formula, the student will be able to calculate correctly the mutual inductance of two coils.

4.16.7 Given a set of problems, the student will be able to calculate correctly the total inductance in series or parallel.

4.16.8 Given a single layer coil and the basic formula, the student will be able to correctly calculate the inductance of a coil.

SUGGESTED LEARNING ACTIVITIES:

Demonstrate the effect of placing two inductors in series.

Demonstrate the effect of placing two inductors in parallel.

View film: *Inductance*, United World Films, Inc., 1445 Park Avenue, N.Y. 10029, 35 minutes.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL 4: **The student will be able to use basic electrical/electronic theory and related mathematics.**

COMPETENCIES: The Student will be able to:

4.17 define and calculate RL time constant.

PERFORMANCE INDICATORS:

4.17.1 Given a diagram of an RL circuit, the student will be able to write a definition of an RL time constant.

4.17.2 Given the mathematical equation, the student will be able to calculate time in a series RL Circuit.

4.17.3 Given the appropriate symbols, the student will be able to write the formula for RL Time Constant.

4.17.4 Given value of inductance and resistance, and a universal time constant curve, the student will be able to determine the values of I and E at any instant in time.

4.17.5 Given circuit with unknown values of R and L, the student will be able to calcualte R and L in a series R-L Circuit.

SUGGESTED LEARNING ACTIVITIES:

RL time constant, Module EL-CT-02.

SUGGESTED TOPICS: (For your own use

COURSE GOAL 4: The student will be able to use basic electrical/electronic theory and related mathematics.

COMPETENCIES: The Student will be able to:

4.18 define and calculate inductive reactance.

PERFORMANCE INDICATORS:

4.18.1 Given the mathematical equation, the student will be able to calculate inductive reactance of a circuit.

4.18.2 Given a list of definitions, the student will be able to select the proper definition of inductive reactance.

4.18.3 Given circuit values, the student will be able to calculate total inductive reactance in series or parallel.

4.18.4 Given proper circuit values, the student will be able to calculate inductance or frequency by using the reactance formula.

4.18.5 Given circuit values, the student will be able to calculate inductance by using Ohm's Law.

4.18.6 The student will be able to state the current and voltage phase relationship of an inductive circuit.

SUGGESTED LEARNING ACTIVITIES:

Inductive reactance, Module EL-CT-01.

SUGGESTED TOPICS: (For your own use

COURSE GOAL 4: The student will be able to use basic electrical/electronic theory and related mathematics.

COMPETENCIES: The Student will be able to:

4.19 explain transformers.

PERFORMANCE INDICATORS:

4.19.1 The student will be able to state, in writing, the theory of transformer operation.

4.19.2 Given the turns ratio, the student will be able to predict the voltage and current available to a load from a given input.

4.19.3 Given the input and output voltage, the student will be able to calculate turns ratio.

4.19.4 The student will be able to name the primary losses inherent in transformers.

SUGGESTED LEARNING ACTIVITIES:

Tranformers, Module EL-BC-16.

View film: *How Transformers Work*, MSU, 15 minutes, rental.

Take a field trip to Portland General Electric Co., Transformer Shop Service Center, SE 17th Street, Portland.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL 4: The student will be able to use basic electrical/electronic theory and related mathematics.

COMPETENCIES: The Student will be able to:

4.20 explain capacitance.

PERFORMANCE INDICATORS:

4.20.1 Given a capacitor, the student will be able to physically describe it, including the naming of its parts and their relationship to the capacitance of the capacitor.

4.20.2 The student will be able to state the unit of capacitance and relate it to the physical size of capacitor.

4.20.3 Given symbols and diagrams, the student will be able to describe the function of a capacitor to include charging, discharging and storage of a charge in a capacitor.

4.20.4 Given two or more capacitors connected in either series or parallel, the student will be able to compute their combined capacitance and working voltage.

4.20.5 Given a list of terms, the student will be able to name the five most common types of commercial capacitors, including their physical and electrical characteristics.

4.20.6 Given a list of the characteristics of a capacitor, the student will be able to state and define: the unit of capacitance; capacitance; tolerance; voltage rating; temperature coefficient; leakage resistance and power factor.

4.20.7 Given a capacitor of unknown quality and an ohmmeter, the student will be able to determine if it is open, shorted or leaking.

SUGGESTED LEARNING ACTIVITIES:

Capacitance, Module EL-BC-17.

Take a field trip to visit power company substations locally or around the state.

View film: *Capacitance*, United World Films, Inc., 1445 Park Avenue, N.Y. 10029, 31 minutes.

View film: *Capacitance*, University of Michigan, 31 minutes.

View film: *Capacitance*, University of Illinois, 30 minutes.

View film: *RCL: Resistance-Capacitance*, University of Illinois, 30 minutes.

Check the condition of several capacitors using the VOM.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL 4: **The student will be able to use basic electrical/electronic theory and related mathematics.**

COMPETENCIES: The Student will be able to:

4.21 define and calculate RC time constant.

PERFORMANCE INDICATORS:

4.21.1 The student will be able to write a definition of RC time constant.

4.21.2 Given proper circuit values, the student will be able to calculate RC time constants of a capacitive circuit.

4.21.3 Given a universal time constant curve, the student will be able to calculate problems concerning RC time on the chart.

4.21.4 Given the circuit with unknown values of R and C, the student will be able to calculate resistance or capacitance in an RC circuit.

SUGGESTED LEARNING ACTIVITIES:

RC time constant, Module EL-CT-04.

Determine experimentally the time required to charge and discharge a capacitor through a resistor.

SUGGESTED TOPICS: (For your own use)

COMPETENCIES: The Student will be able to:

4.22 define and calculate capacitive reactance.

4.23 measure and calculate series impedance.

PERFORMANCE INDICATORS:

4.22.1 Given proper circuit values, the student will be able to compute capacitive reactance of a circuit.

4.22.2 The student will be able to define capacitive reactance.

4.22.3 Given circuit values, the student will be able to calculate total capacitive reactance in series or parallel.

4.22.4 Given proper circuit values, the student will be able to compute capacitance or frequency by using the capacitive reactance formula.

4.22.5 Given proper circuit values, the student will be able to apply Ohm's Law for finding capacitance of a circuit.

4.22.6 The student will be able to state the current and voltage phase relationship of a capacitive circuit.

4.23.1 Given a series AC circuit (RC, RL, RLC), the student will be able to calculate the magnitude and phase angle of the impedance.

4.23.2 Given a mathematical solution for Z, the student will be able to express the impedance in either rectangular or polar form. He/she will also be able to convert from one form to the other.

4.23.3 Given an impedance bridge, the student will be able to measure the impedance of a series AC circuit to within the practical limitations imposed by the components and the test equipment.

SUGGESTED LEARNING ACTIVITIES:

Capacitive reactance, Module EL-CT-03.

Series impedance, Module EL-CT-07.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL 4: The student will be able to use basic electrical/electronic theory and related mathematics.

COMPETENCIES: The Student will be able to:

4.24 measure and calculate parallel impedance.

4.25 explain resonance.

PERFORMANCE INDICATORS:

4.24.1 Given a parallel AC Circuit (RC, RL, or RLC), the student will be able to calculate the total impedance. He/she will also be able to express the impedance in either polar or rectangular form.

4.24.2 Given the impedance in rectangular form, the student will be able to calculate the admittance, conductance and susceptance.

4.24.3 Given an impedance bridge, the student will be able to measure the impedance to a parallel circuit to within the practical limits imposed by the components and test equipment.

4.25.1 Given a list of terms, the student will be able to select the correct definition or mathematical expression of the condition of resonance.

4.25.2 Given the formulas and necessary data, the student will be able to calculate for the unknown value of the resonant frequency, circuit capacitance or inductance.

4.25.3 The student will be able to describe or select from a given list the effects of changing L or C in a tuning circuit, and how this is accomplished.

SUGGESTED LEARNING ACTIVITIES:

Parallel impedance, Module EL-CT-08.

Resonance, Module EL-BC-18.

SUGGESTED TOPICS: (For your own use

COURSE GOAL 4: The student will be able to use basic electrical/electronic theory and related mathematics.

COMPETENCIES: The Student will be able to:

4.26 measure, define and calculate series resonant circuits.

4.27 measure, define and calculate parallel resonant circuits.

PERFORMANCE INDICATORS:

4.26.1 Given a value for L and C, the student will be able to calculate within slide rule accuracy the resonant frequency.

4.26.2 Given a value for resonant frequency and a value for either L or C, the student will be able to calculate the value of the unknown. This will be done within slide rule accuracy.

4.26.3 Given the necessary equipment, the student will be able to measure the resonant frequency of a series L-C circuit.

4.26.4 Given a list of terms, the student will be able to list four characteristics of a series resonant circuit.

4.27.1 Given a value of L and C, the student will be able to calculate the resonant frequency of a parallel L-C circuit.

4.27.2 Given the resonant frequency and either L or C, the student will be able to calculate the unknown value.

4.27.3 Given the necessary equipment, the student will be able to measure the resonant frequency of an L-C circuit.

4.27.4 Given a list of terms, the student will be able to list four characteristics of a parallel resonant circuit.

SUGGESTED LEARNING ACTIVITIES:

Series resonant circuit, Module EL-CT-10.

Parallel resonant circuit, Module EL-CT-11.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL 4: The student will be able to use basic electrical/electronic theory and related mathematics.

COMPETENCIES: The Student will be able to:

4.28 define and calculate circuit Q and bandwidth.

PERFORMANCE INDICATORS:

4.28.1 Given the appropriate figures and symbols, the student will be able to define and express mathematically the Q of a resonant circuit.

4.28.2 Given the necessary data, the student will be able to compute the Q of a resonant circuit.

4.28.3 Given a list of definitions, the student will be able to select the definition of bandwidth.

4.28.4 Given a set of graphs, the student will be able to define or express the effects of Q on a resonant circuit.

4.28.5 Given the formula and necessary data or the response curve of a resonant circuit, the student will be able to compute the bandwidth.

4.28.6 Given a list of possible effects, the student will be able to define or select the effects of damping on parallel resonant circuits.

SUGGESTED LEARNING ACTIVITIES:

Circuit Q and bandwidth, Module EL-CT-12.

SUGGESTED TOPICS: (For your own use)

COMPETENCIES: The Student will be able to:

4.29 explain filter networks.

4.30 describe the DC generator.

PERFORMANCE INDICATORS:

4.29.1 Given the necessary information, the student will be able to draw the schematic diagram and explain how low pass and high pass filters operate.

4.29.2 Given the necessary information, the student will be able to draw the schematic diagram and explain the operation of a band pass filter.

4.29.3 Given the necessary information, the student will be able to draw the schematic diagram and explain the operation of a band elimination filter.

4.29.4 Given the necessary equipment and parts, the student will be able to determine the resonant frequency or band of frequencies that will be eliminated or passed to a load.

4.30.1 Given the term "DC generator," the student will be able to describe the functions and makeup of the various DC generators and their components.

4.30.2 Given a simple DC generator, the student will be able to identify the basic parts and explain their function.

SUGGESTED LEARNING ACTIVITIES:

Filter network, Module EL-CT-13.

DC Generators, Module EL-BC-32.

Show parallel with automotive generators and describe their job.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 4: The student will be able to use basic electrical/electronic theory and related mathematics.

COMPETENCIES: The Student will be able to:

4.31 describe the alternator.

4.32 describe the DC motor.

4.33 describe the AC motor.

PERFORMANCE INDICATORS:

4.31.1 Given the term "alternator," the student will be able to describe the characteristics of the various types of alternators.

4.31.2 Given a demonstration model of a simple automobile alternator, the student will be able to identify the basic parts and trace the current flow through the rectifiers to the battery.

4.32.1 Given the term "DC motor," the student will be able to describe the various types of motors and their components.

4.32.2 Given a DC motor, the student will be able to identify and explain the basic parts of that motor.

4.33.1 Given the term "AC motor," the student will be able to describe the various types of AC motors, their uses and their operation.

4.33.2 Given a demonstration model or a diagram of an AC motor, the student will be able to identify its basic parts.

SUGGESTED LEARNING ACTIVITIES:

Alternators, Module EL-BC-33.

Show parallel with automotive alternators and describe their job.

DC motors, Module EL-BC-34.

AC motors, Module EL-BC-35.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL 4: The student will be able to use basic electrical/electronic theory and related mathematics.

COMPETENCIES: **The Student will be able to:**

4.34 describe the electronic vacuum tube.

4.35 explain the diode vacuum tube.

PERFORMANCE INDICATORS:

4.34.1 The student will be able to describe electron tubes, how they function and what their application is in the field of electronics.

4.35.1 The student will be able to list two factors that determine the place current in a tube diode.

4.35.2 The student will be able to state the bias polarity needed across the diode to control the electron flow in the vacuum tube.

4.35.3 Given drawing materials, the student will be able to sketch the schematic symbol and label the terminals for each of the two types of vacuum tube diodes.

4.35.4 Given drawing materials, the student will be able to sketch and label the plate characteristics of a typical tube diode.

4.35.5 The student will be able to write a definition of operating terms used with tube diodes.

4.35.6 Given a tube manual, the student will be able to list the major operating parameters of a tube diode.

SUGGESTED LEARNING ACTIVITIES:

View film: *Vacuum Tubes*, Missouri University, 11 minutes.

View film: *Vacuum Tubes*, Brigham Young University, 30 minutes.

View film: *The principle of the Gas Filled Tube*, University of Illinois, 15 minutes.

The tube diode, Module EL-DV-01.

Remove envelope of various tubes and tag respective elements.

Help student become acquainted with tube characteristics through use of tube manuals.

Using a dynamic demonstrator and an oscilloscope, study the effects of diode and triode operations.

Hang up wall charts on *Vacuum Tube Construction*, (set of six) from Sylvania Electric Products, Inc., 1740 Broadway, N.Y. 10036.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL 4: The student will be able to use basic electrical/electronic theory and related mathematics.

COMPETENCIES: **The Student will be able to:**

4.36 explain the characteristics of a triode vacuum tube.

4.37 explain solid state junctions and diodes.

PERFORMANCE INDICATORS:

4.36.1 Given a list of materials and instructions, the student will be able to measure and plot the plate characteristics of a triode tube.

4.36.2 Given a graph of plate characteristics and various parameters, the student will be able to find the operating conditions of the tube.

4.36.3 The student will be able to describe how the grid controls the flow of electrons in a triode tube.

4.36.4 Given drawing materials, the student will be able to draw and label the schematic symbol of a triode tube.

4.37.1 Given a list, the student will be able to identify the basic characteristics of N and P type materials.

4.37.2 Given a schematic, the student will be able to indicate current flow in a PN junction.

4.37.3 Given a list, the student will be able to select characteristics of a PN junction.

4.37.4 Given the appropriate symbols, the student will be able to show correctly the forward and reverse biasing of a PN junction diode.

4.37.5 Given a diode characteristic curve, the student will be able to select four characteristics.

SUGGESTED LEARNING ACTIVITIES:

Triode characteristics, Module EL-DV-08.

View film: *The Triode: Amplication*, University of Illinois, 14 minutes.

View film: *Transistors: Triode Fundamentals*, U.S. Navy, free.

View film: *The Diode, Principles and Application*, University of Illinois, 17 minutes.

Introduction to Diodes, Module EL-DV-02.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: **4: The student will be able to use basic electrical/electronic theory and related mathematics.**

COMPETENCIES: The Student will be able to:

4.38 use semiconductor diodes.

4.39 explain the zener diode.

PERFORMANCE INDICATORS:

4.38.1 Given three circuits, the student will be able to set up and measure them, using diodes that act as a steering circuit, perform amplitude detection and limit voltage.

4.38.2 Given six schematic diagrams, the student will be able to determine the output voltage in five diode circuits.

4.39.1 Given the appropriate materials, the student will be able to sketch and label the forward and reverse electrical characteristics curve of a zener diode.

4.39.2 Given the appropriate materials, the student will be able to sketch and label the schematic symbol of a zener diode.

4.39.3 Given three circuit diagrams, the student will be able to calculate the current and power in a zener diode.

4.39.4 Given the circuit diagrams and instructions, the student will be able to do an experiment showing the characteristics and the use of a zener diode as a voltage regulator.

SUGGESTED LEARNING ACTIVITIES:

Using semiconductor diodes, Module EL-DV-03.

Check semiconductors with ohmmeter.

The zener diode, Module EL-DV-11.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL 4: The student will be able to use basic electrical/electronic theory and related mathematics.

COMPETENCIES: **The Student will be able to:**

4.40 explain the silicon control rectifier (SCR).

4.41 explain the characteristics of transistors.

PERFORMANCE INDICATORS:

4.40.1 Given drawing materials, the student will be able to sketch and label the schematic symbol of an SCR.

4.40.2 Given an SCR number and a manual, the student will be able to list the important operating parameters of an SCR.

4.40.3 Given an SCR, the student will be able to measure and plot its electrical characteristics.

4.40.4 Given a light dimmer circuit, the student will be able to set up and measure the operating characteristics of an SCR.

4.41.1 Given block diagrams, the student will be able to indicate correctly the current paths of a PNP and NPN transistor.

4.41.2 Given an appropriate drawing, the student will be able to identify correctly base diagrams of transistors.

4.41.3 Given the circuit parameters, the student will be able to calculate the beta and alpha of a transistor.

4.41.4 Given a list of transistor characteristics, the student will be able to identify proper letter (parameter) symbols.

4.41.5 Given the appropriate transistors and resistors, the student will be able to state the general rule for biasing transistors and complete the biasing arrangement of an NPN and PNP transistor.

SUGGESTED LEARNING ACTIVITIES:

The SCR, Module EL-DV-05.

View *Practical Transistor Series*, Hewlett Packard Co., 15 videotapes.

Introduction to transistors, Module EL-DV-04.

View film: *Genesis of the Transistor*, Bell Telephone Co.

View film: *Principles of Transistors*, University of Illinois, 22 minutes.

View film: *The Transistor*, Bell Telephone Co., 10 minutes.

View film: *Transistors an Introduction*, U.S. Navy, free.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL 4: **The student will be able to use basic electrical/electronic theory and related mathematics.**

COMPETENCIES: The Student will be able to:

4.42 explain the characteristics of the field effect transistor (FET).

4.43 explain amplification.

PERFORMANCE INDICATORS:

4.42.1 Given the parameters, transistor number and a manual, the student will be able to list four parameters of an FET.

4.42.2 Given drawing materials, the student will be able to sketch the schematic symbol for a P-channel and N-channel FET.

4.42.3 Given a list of materials and instructions, the student will be able to measure and plot the drain characteristics, calculate the input resistance and the voltage and current gain of an FET.

4.43.1 Given a list of definitions, the student will be able to express mathematically or select the definition of gain.

4.43.2 Given a list of definitions, the student will be able to express mathematically or select the definitions of the amplification factor, Mu, Alpha, Beta.

4.43.3 Given a list, the student will be able to define or select the amplifier classes A, B and C.

4.43.4 Given a list, the student will be able to describe or select how voltage amplification results from a change in current through the amplifier load.

SUGGESTED LEARNING ACTIVITIES:

The field effect transistor (FET), Module EL-DV-12.

Amplification, Module EL-CT-15.

SUGGESTED TOPICS: (For your own use)

COMPETENCIES: The Student will be able to:

4.44 explain transistor voltage amplifiers.

4.45 explain basic triode amplifiers.

PERFORMANCE INDICATORS:

4.44.1 Given the schematic diagram of a common base amplifier, common emitter amplifier and common collector amplifier, the student will be able to write the distinguishing characteristics of each.

4.44.2 Given the collector curves and loadlines, the student will be able to calculate the operating point, Q, collector, emitter and base currents, collector and load voltages, voltage, current and power gains.

4.44.3 Given an emitter amplifier and a set of figures, the student will be able to set up and measure the operating conditions of a common emitter amplifier to verify load line calculations.

4.45.1 Given a schematic diagram and instructions, the student will be able to set up, measure and calculate the voltage, current and power gain of a single stage common cathode triode amplifier.

4.45.2 Given an amplifier and figures, the student will be able to calculate the voltage, current and power gain of the amplifier.

4.45.3 Given drawing materials, the student will be able to sketch a diagram of the phase relationship between the input and output voltage.

SUGGESTED LEARNING ACTIVITIES:

Transistor load lines, Module EL-CT-17.

Tube load lines, Module EL-CT-18.

Tube bias circuit, Module EL-CT-16.

SUGGESTED TOPICS: (For your own use)

COMPETENCIES: The Student will be able to:

4.46 explain power supply rectifiers.

PERFORMANCE INDICATORS:

4.46.1 Given the necessary information, the student will be able to draw and explain the operation of a half wave rectifier.

4.46.2 Given the necessary information, the student will be able to draw and explain the operation of a full wave rectifier.

4.46.3 Given the necessary information, the student will be able to draw and explain the operation of a bridge rectifier.

4.46.4 Given the necessary information, the student will be able to draw and explain the operation of a voltage doubler.

4.46.5 Given a rectifier circuit of some type, the student will be able to calculate its peak or average output voltage and draw waveforms expected.

4.46.6 Given the circuit requirements, the student will be able to design and/or construct and take the necessary readings to prove the correctness of the circuit.

SUGGESTED LEARNING ACTIVITIES:

Power supply rectifiers, Module EL-CT-30.

SUGGESTED TOPICS: (For your own use)

COMPETENCIES: The Student will be able to:

4.47 explain power supply filters.

4.48 manipulate basic arithmetic operations.

PERFORMANCE INDICATORS:

4.47.1 Given a power supply diagram, the student will be able to draw and explain the operation of a capacitor input filter.

4.47.2 Given a power supply diagram, the student will be able to draw and explain the operation of a choke input filter.

4.47.3 The student will be able to compare the advantages and disadvantages of a capacitor input and choke input filter.

4.47.4 Given a filter circuit, the student will be able to calculate and explain the purpose of the bleeder resistor.

4.47.5 Given the requirements for a filter circuit, the student will be able to select the proper values and construct a power supply filter to give satisfactory performance.

4.48.1 Given a set of problems and formulas, the student will be able to solve, neatly and efficiently, practical problems in electricity involving:

a. addition of whole numbers
b. subtraction of whole numbers
c. multiplication of whole numbers
d. division of whole numbers.

4.48.2 The student will be expected to achieve at least 80 percent accuracy, and the written solutions must be neat and clearly written, showing all work.

SUGGESTED LEARNING ACTIVITIES:

Power supply filters, Module EL-CT-31.

Arithmetical operations, Module EL-RS-37.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL **4: The student will be able to use basic electrical/electronic theory and related mathematics.**

COMPETENCIES: **The Student will be able to:**

4.49 compute fractions.

4.50 compute powers and roots.

PERFORMANCE INDICATORS:

4.49.1 Given two or more fractions, the student will add, subtract, multiply or divide them with 80 percent of the answers correct.

4.49.2 Given problems with fractions or decimals, the student will select the correct method of solution 100 percent of the time.

4.49.3 Given fractions or decimals, the student will convert one to the other from a table, with 100 percent accuracy. For fractions or decimals not in the table, the answers will be at least 80 percent accurate.

4.50.1 Given a number of one to four digits, the student will square these numbers with 90 percent accuracy.

4.50.2 Given numbers that can be located in a table of squares, the student will square these numbers with 100 percent accuracy.

4.50.3 Given numbers that can be located in a table of square roots, the student will find the square roots with 100 percent accuracy.

4.50.4 Given problems that require squaring or square roots, the student will perform these operations and solve the problems with 80 percent accuracy.

SUGGESTED LEARNING ACTIVITIES:

Fractions, Module EL-RS-38.

Powers and roots, Module EL-RS-41.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL 4: **The student will be able to use basic electrical/electronic theory and related mathematics.**

COMPETENCIES: The Student will be able to:

4.51 use ratio and proportion.

4.52 use scientific notation.

PERFORMANCE INDICATORS:

4.51.1 Given two numerical quantities, the student will be able to write them as a ratio and reduce them to simplest whole number terms and to decimal terms.

4.51.2 Given quantities that can be expressed as ratio, but having one unknown quantity, the student will be able to use the proportion method for finding the unknown.

4.52.1 Given a list of numbers in decimal form and a list of scientific notation, the student will be able to change the numbers from one form to the other with 100 percent accuracy.

4.52.2 Given a list of numbers with electronic prefixes, the student will be able to write these numbers with powers of ten with 90 percent accuracy.

4.52.3 Given a list of numbers, the student will be able to round each number to a given number of significant digits with 100 percent accuracy.

4.52.4 Given many problems containing multiplying and/or dividing, the student will be able to change these numbers to scientific notation, find the placement of the decimal point correctly for each problem and estimate the answer to one digit (this digit being within two or three units from the correct answer).

SUGGESTED LEARNING ACTIVITIES:

Ratio and proportion, Module EL-RS-39.

Scientific notation for the slide rule, Module EL-RS-31.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 4: The student will be able to use basic electrical/electronic theory and related mathematics.

COMPETENCIES: The Student will be able to:

4.53 compute percent and tolerance.

4.54 calculate db units.

PERFORMANCE INDICATORS:

4.53.1 Given a measurement, the student will be able to calculate any specified percent of the measurement.

4.53.2 Given two quantities, the student will be able to compare them as a percent. This also includes discount problems and percent change.

4.53.3 Given the tolerance of a measurement expressed in percent, the student will be able to determine the upper and lower limits of the measurement.

4.54.1 The student will be able to explain why the decibel unit is so useful in working with sound levels and circuit gains.

4.54.2 The student will be able to use the power ratios of 1, 3, 6, 10, 20 db to calculate approximate output or input powers without using logarithmic formulas. Slide rule accuracy is sufficient.

4.54.3 The student will be able to use logarithmic formulas, slide rule and log tables to calculate decibel problems involving power, voltage and current gain. Slide rule accuracy is sufficient.

SUGGESTED LEARNING ACTIVITIES:

Percent and tolerance, Module EL-RS-40.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 4: The student will be able to use basic electrical/electronic theory and related mathematics.

COMPETENCIES: The Student will be able to:

4.55 use algebra.

PERFORMANCE INDICATORS:

4.55.1 Given the following list, the student will be able to correctly name terms or symbols used in algebra or match the terms with examples:

a.	equation	h.	terms and like terms
b.	subscript notation	i.	factor
c.	process symbols	j.	numerator
d.	prime notation	k.	denominator
e.	coefficient	l.	divisor
f.	exponent	m.	parentheses
g.	integer	n.	reciprocal

4.55.2 Given a set of data, the student will be able to solve equations in which unknowns appear as:

a. a term
b. a factor
c. a divisor

4.55.3 Given formulas and data, the student will be able to solve equations of the following types:

a. involving exponents and radicals,
b. involving a combination of terms and factors.

SUGGESTED LEARNING ACTIVITIES:

Review of algebra, Module EL-RS-43.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 4: The student will be able to use basic electrical/electronic theory and related mathematics.

COMPETENCIES: **The Student will be able to:**

4.56 solve right triangle problems.

PERFORMANCE INDICATORS:

4.56.1 Given any two sides of a right triangle, the student will be able to find the third side with 90 percent accuracy.

4.56.2 Given any two of three values of the resistance, impedance and reactance, the student will be able to find the third value with 90 percent accuracy.

4.56.3 Given the values for the necessary parts of a right triangle, the student will find the value of the ratios of sine, cosine or tangent with 90 percent accuracy.

4.56.4 Given the required minimum parts of a right triangle, the student will find all the missing parts with 90 percent accuracy.

4.56.5 Given the size of angles, the student will find the value for the sine, cosine or tangent from the trigonometric tables with 100 percent accuracy.

SUGGESTED LEARNING ACTIVITIES:

Right triangles, Module EL-RS-42.

SUGGESTED TOPICS: (For your own use

COURSE GOAL: 4: The student will be able to use basic electrical/electronic theory and related mathematics.

COMPETENCIES: The Student will be able to:

4.57 solve phasor problems.

PERFORMANCE INDICATORS:

4.57.1 Given the terms scalar, vector and phasor, the student will be able to define and tell where they are used in electricity.

4.57.2 Given eight problems requiring the addition of phasors, the student will convert them to rectangular form if necessary, add them and write the results in two forms—polar and rectangular. The student must solve at least six correctly.

4.57.3 Given eight problems requiring the multiplication or division of phasors, the student will convert them to polar form if necessary, perform the indicated operation, and write the result in polar and rectangular form.

SUGGESTED LEARNING ACTIVITIES:

Phasors, Module EL-RS-44.

View film: *Vectors*, University of Illinois, 11 minutes.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 4: The student will be able to use basic electrical/electronic theory and related mathematics.

PERSONAL DEVELOPMENT AND LEADERSHIP

COMPETENCIES: The Student will be able to:

5.1 establish and pursue goals based on personal values.

PERFORMANCE INDICATORS:

5.1.1 Given a topic and writing materials, the student will be able to write a goal statement based on his/her personal values. The statement must apply to him/her personally, be realistic and be specific. A list of probable barriers, ways of attacking the barriers and a time frame for goal completion must be included in the statement.

5.1.2 Given a discussion of learning habits and writing materials, the student will be able to write a minimum of two pages about his/her personal learning habits and evaluate his/her concentration, memory, listening and communication skills. Based on this evaluation, the student will be able to list at least two possible goals that he/she could work on. The goals must be personal, specific and reasonable.

5.1.3 Given a time analysis model and writing materials, the student will be able to complete a five-day personal time analysis to determine how he/she spends his/her time and identify at least two goals that he/she could establish that would help use the time more effectively.

5.1.4 Given writing materials, the student will be able to make a list of at least twenty-five skills, attitudes, or habits that he/she believes are associated with leadership. He/she will select one of these and write a paragraph explaining how he/she intends to practice that skill, attitude or habit.

SUGGESTED LEARNING ACTIVITIES:

Have the student read these reference materials:

Williams, J. Clifton. "Developing Commitment for Career Success," *Motivation for Career Success*. Waco, Texas: Education Achievement Corporation, 1972 (tapes or booklets).

Laird, Donald A., and Laird, Elenor. *Psychology: Human Relations and Motivation*. New York: McGraw-Hill, 1967, pp. 57-60, 137-152 and 243-263.

Williams, J. Clifton. "Developing Habits for Career Success," *Motivation for Career Success*. Waco, Texas: Education Achievement Corp., 1972.

Laird, Donald A., and Laird, Elenor. *Psychology: Human Relations and Motivation*. New York: McGraw-Hill, 1967, pp. 74-136.

Flesch, Rudolph. *The Art of Clear Thinking*. New York: Harper and Row, 1951.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 5: The student will be able to demonstrate personal development and leadership skills that are appropriate for electrical workers.

COMPETENCIES: The Student will be able to:

5.1 establish and pursue goals based on personal values. (continued)

PERFORMANCE INDICATORS:

5.1.5 Given job descriptions and writing materials, the student will be able to complete a written occupational career analysis of a career of his/her choice. The student must discuss aptitudes and training needed for entry and advancement, earnings progression, duties performed at various levels, and factors that he/she personally considers to be major advantages or disadvantages (two pages minimum).

5.1.6 Given a hypothetical situation and writing materials, the student will be able to:

a. describe a situation in which he/she has to make a decision that was important to him/her.
b. compare his/her behavior in that decision-making situation with the four-step decision-making process.
c. evaluate his/her problem-solving abilities and state at least two goals which would increase his/her ability in this area.

5.1.7 The student will be able to given evidence that he/she is able to set and pursue personal goals by identifying, setting and performing goals within the classroom setting.

SUGGESTED LEARNING ACTIVITIES:

Williams, J. Clifton. "Developing a Life Style for Intelligent Action," *Motivation for Career Success*. Waco, Texas: Education Achievement Corp., 1972 (tapes or booklets).

Laird, Donald A., and Laird, Elenor. *Psychology: Human Relations and Motivation*. New York: McGraw-Hill, 1967, pp. 25-49.

Williams, J. Clifton. "Developing Leadership Ability for Career Success," *Motivation for Career Success*. Waco, Texas: Education Achievement Corp., 1972 (tapes or booklets).

Laird, Donald A., and Laird, Elenor. *Psychology: Human Relations and Motivation*. New York: McGraw-Hill, 1967, pp. 369-428.

Williams, J. Clifton. "Planning for Career Success," *Motivation for Career Success*. Waco, Texas: Education Achievement Corp., 1972 (tapes or booklets).

Wood, Robert. *Opportunities in Electrical Trades*. Louisville, KY: Vocational Guidance, Inc.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 5: The student will be able to demonstrate personal development and leadership skills that are appropriate for electrical workers.

COMPETENCIES: The Student will be able to:

5.1 establish and pursue goals based on personal values. (continued)

PERFORMANCE INDICATORS:

SUGGESTED LEARNING ACTIVITIES:

Electrical Assembler, Module EL-CA-01
Construction Electrician, Module EL-CA-02
Maintenance Electrician, Module EL-CA-03
Appliance Repairperson, Module EL-CA-04
Electronic Technician, Module EL-CA-05

Occupational Outlook Handbook (Bulletin 1785). Washington, D.C., U.S. Government Printing Office.

Dictionary of Occupational Titles (Vol. 1 & 2). Washington, D.C., U.S. Government Printing Office.

Williams, J. Clifton. "Developing Leadership Ability for Career Success," *Motivation for Career Success.* Waco, Texas: Education Achievement Corp., 1972 (tapes or booklets).

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 5: The student will be able to demonstrate personal development and leadership skills that are appropriate for electrical workers.

COMPETENCIES: The Student will be able to:

5.1 establish and pursue goals based on personal values. (continued)

5.2 secure job leads.

PERFORMANCE INDICATORS:

5.2.1 Given the following sources, the student will be able to produce at least five job leads:

a. newspaper want ads
b. friend, relatives, teachers
c. state and private employment agencies
d. civil service office
e. cold canvassing
f. high school counselors
g. Chamber of Commerce

SUGGESTED LEARNING ACTIVITIES:

Have the student:

a. choose a goal that he/she wishes to work on,
b. make appointment with instructor,
c. complete a learning contract with the instructor. The contract should identify the following:
   1. THE GOAL written on a completed Standard Goal Form.
   2. activities that will evidence pursuit of the goal.
   3. a way to identify successful completion.
   4. a timeline for checkups and for completion.
d. meet with the instructor at the times indicated on the contract for checkups and final evaluation.

"Getting Job Leads," *The Job Hunt*. Coronet Instructional Media, 65 E. South Water Street, Chicago, IL 60601.

Kimbrell, Grady, and Vineyard, Ben S. *Succeeding in the World of Work*. Bloomington, IL: McKnight, 1975 (This text is useful for many areas of personal development).

"Job Hunting: Where to Begin." Tape-Slide-Booklet, Guidance Associates, 757 3rd Avenue, New York, N.Y. 10017.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 5: The student will be able to demonstrate personal development and leadership skills that are appropriate for electrical workers.

COMPETENCIES: The Student will be able to:

5.3 build a personal resume.

5.4 write a letter of introduction.

5.5 interview for a job.

PERFORMANCE INDICATORS:

5.3.1 Given the correct format, the student will be able to build a resume.

5.4.1 Given the proper form and content, the student will be able to write a letter of introduction to get an interview.

5.5.1 Given instruction in job interview techniques, the student will be able to successfully complete a job interview.

SUGGESTED LEARNING ACTIVITIES:

"Building Your Resume," *The Job Hunt*, Coronet.

"Writing Letters of Introduction," *The Job Hunt*. Coronet.

"Preparing for Your Interview," *The Job Hunt*. Coronet.

"Making the Most of Your Job Interview," New York Life Insurance Co.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 5: The student will be able to demonstrate personal development and leadership skills that are appropriate for electrical workers.

COMPETENCIES: The Student will be able to:

5.6 fill out a job application.

5.7 follow up on an interview.

5.8 discuss reasons for the necessity of organized labor in our society.

PERFORMANCE INDICATORS:

5.6.1 Given sample job application forms, the student will be able to correctly fill them out.

5.7.1 Given several job offers and rejections, the student will be able to demonstrate proper methods for accepting or rejecting a job offer, responding to a rejection notice and obtaining information on the status of an application.

5.8.1 The student will be able to:

a. write a two-page explanation on "The major issue in the history of organized labor,"

b. discuss the above paper in a class discussion centered around the above topic. Compare ideas of what the "major issue" is.

SUGGESTED LEARNING ACTIVITIES:

"Filling out Job Applications," *The Job Hunt*. Coronet.

"Following up Your Interview," *The Job Hunt*. Coronet.

Book: *A Brief History of the American Labor Movement.* U.S. Government Printing Office, Bulletin 1000, 1970 ed.

Pamphlets:

1. *Why Unions?*
2. *Collective Bargaining Democracy On The Job.*
3. *This is the AFL-CIO.*

AFL-CIO, 815 16th Street NW, Washington, D.C. 20006.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 5: The student will be able to demonstrate personal development and leadership skills that are appropriate for electrical workers.

COMPETENCIES: The Student will be able to:

5.9 read and interpret a labor contract.

5.10 analyze and suggest solutions to typical human relations problems in work settings.

5.11 demonstrate punctuality and regular work attendance.

PERFORMANCE INDICATORS:

5.9.1 Given a labor contract, the student will be able to explain the meaning of the following terms with reference to current labor contracts in the electrical field:

open shop	closed shop	escalator clause
sickness benefits	agency shop	bargaining unit
incentive pay	severance pay	union shop
fringe benefits	seniority	grievance

5.10.1 Given a case study in which a worker has made a human relations mistake, the student will discuss, in a group, possible ways the problem could have been avoided or corrected. The student should be able to raise questions about the problem, suggest a solution to the problem, and relate the issues of the problem to personal experience.

5.11.1 The student will be absent or tardy no more than three times per grading period.

SUGGESTED LEARNING ACTIVITIES:

Pamphlet: Jack Barbash, *The Labor Movement in the United States.* The Public Affairs Committee, 381 Park Avenue South, N.Y.

Booklet: Oliver, D. W., and Newman, F. M., *The Rise of Organized Labor.* Xerox Corporations Public Issues Series, 1975.

A variety of case studies are contained in:

Chapman, Elwood N. *Your Attitude is Showing.* Chicago, S.R.A., 1972.

Wheeler, Lon. *An Interpersonal Communication Primer.* Oregon Department of Education, 1975.

Refer to student attendance records.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 5: The student will be able to demonstrate personal development and leadership skills that are appropriate for electrical workers.

COMPETENCIES: The Student will be able to:

5.12 work cooperatively with others.

5.13 demonstrate safe work habits.

5.14 demonstrate desirable attitudes.

PERFORMANCE INDICATORS:

5.12.1 Given an electronic kit and three co-workers, the students will be able to successfully build the kit while demonstrating cooperation within the group.

5.13.1 Given specific safety criteria, the student will be able to follow safety instructions in his/her classroom/shop work.

5.14.1 Given the following criteria, the student will be able, in his/her day-to-day classroom behavior, to demonstrate desirable attitudes:

a. work habits
b. personal action
c. quality of work
d. interest
e. response to direction
f. initiative to improve
g. care of equipment

SUGGESTED LEARNING ACTIVITIES:

Have four students build a kit as a group project.

Keep record of safety infractions. Have class generate appropriate safety guidelines and rules. Post these rules in shop and enforce them.

Place students on school safety committee.

Have student read *Succeeding in the World of Work*, Chapter 4, Kimbrell, Vineyard, McKnight Publishing Co., Bloomington, IL.

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 5: The student will be able to demonstrate personal development and leadership skills that are appropriate for electrical workers.

COMPETENCIES: The Student will be able to:

5.15 function effectively in a vocational youth organization.

PERFORMANCE INDICATORS:

5.15.1 *Given the availability of a Vocational Industrial Club of America, the student will be able to participate in local club activities.*

SUGGESTED LEARNING ACTIVITIES:

Have students form a chapter of Vocational Industrial Club of America (VICA).

SUGGESTED TOPICS: (For your own use)

COURSE GOAL: 5: The student will be able to demonstrate personal development and leadership skills that are appropriate for electrical workers.

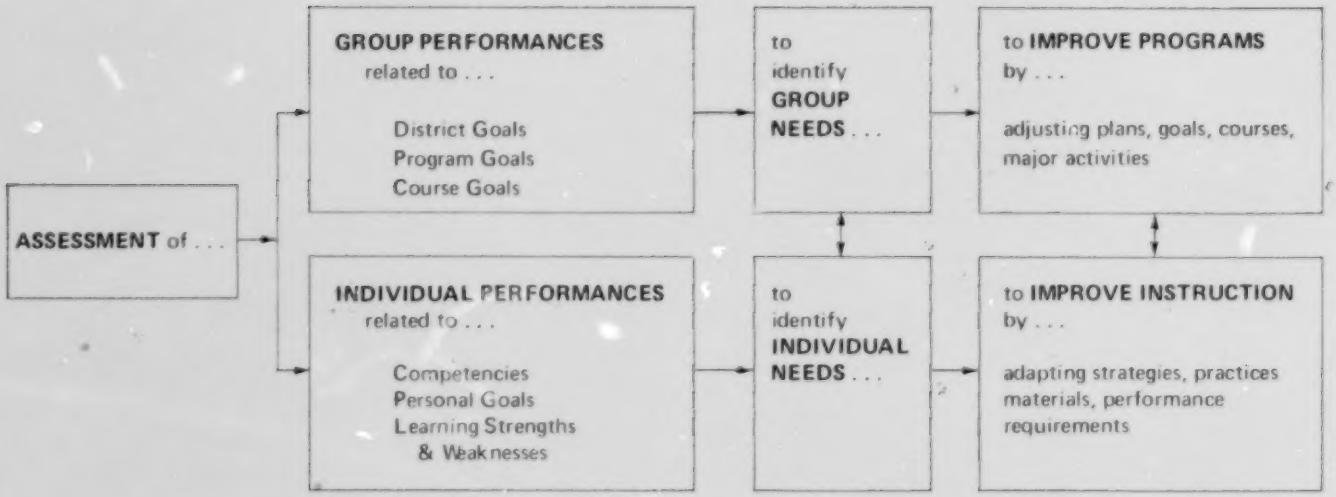
ASSESSMENT

In the Goal-Based Planning for the Electrical Cluster section of this guide, five sets of desired outcomes were identified: (1) state goals; (2) district goals; (3) program goals; (4) course goals; and (5) district identified competencies. Personal goals of individual students were also mentioned. These were followed by specific suggestions (learning activities, teaching strategies, resources, alternative instruction, etc.) designed to assist the planner in implementing a goal-based curriculum.

Once instructional plans are implemented, the teacher must pose the question: Are students attaining desired outcomes, and is the electrical program helping them to reach those outcomes? The quality of the answers to these questions depends on for what purpose and how well assessment activities are designed and carried out.

If it is desirable to know the kind of overall job the electrical program is doing, then the performance of groups of students is significant. Assessment focuses on whether an acceptable majority of students is attaining established goals. The needs of groups of students can then be identified and program planning improved accordingly. If, however, it is desirable to know how well individual students are attaining desired (or required) outcomes, then the performance of each individual student is significant. Assessment focuses on the needs, interests, and learning strengths and weaknesses of individual students as they strive to develop and demonstrate desired outcomes. The needs of individual students can then be identified and learning activities, teaching strategies, resources, etc., adjusted accordingly.

These relationships are shown below. Assessment of each of the elements shown in the figure will provide answers to particular kinds of questions.



Assessment of district goal attainment answers the question: To what extent are students attaining the outcomes of schooling the community and its schools desire?

Assessment of program goal attainment answers the question: To what extent are students attaining the outcomes electrical teachers and curriculum planners desire?

Assessment of course goal (or unit goal) attainment answers the question: To what extent are students attaining the outcomes electrical teachers desire for technical communications and other courses?

Assessment of competency attainment answers the question: To what extent is a student demonstrating desired applications of what has been learned?

Assessment of personal goal attainment answers the question: To what extent is a student attaining those outcomes designated as of greatest personal importance, need or interest?

Assessment of learning strengths and weaknesses answers the question: What characteristics reflected by a student's performance can be seen as enhancing or inhibiting attainment of desired outcomes?

In seeking answers to these questions, student performances that can be accepted as indicators of attainment of desired outcomes must be clear. These performance indicators serve to guide the assessment activity in producing the most needed information.

To be in compliance with state requirements, each district must assure that assessment activities are carried out in relation to three points. Assessment of student attainment of competencies for graduation and identification of the learning strengths and weaknesses are two of these. In addition, the electrical program may be selected by your district for a special kind of assessment required by the state. If this happens, it will be necessary to analyze the goals of the program to determine the extent to which students must develop or apply reading, writing and computing skills in attaining those goals. Assessment will then focus on describing how well the necessary skills are being developed or applied.*

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*How this may be accomplished is described in *Assessment Manual for Electrical Cluster Program Planning,* (Salem: Oregon Department of Education, revised, 1975).

For more information on assessment procedures, see *Planning the Education of Oregon Learners: Completing the Management Cycle* (Salem: Oregon Department of Education, 1975). See also pages 21-26 in *Elementary-Secondary Guide for Oregon Schools: Part II, Suggestions.*

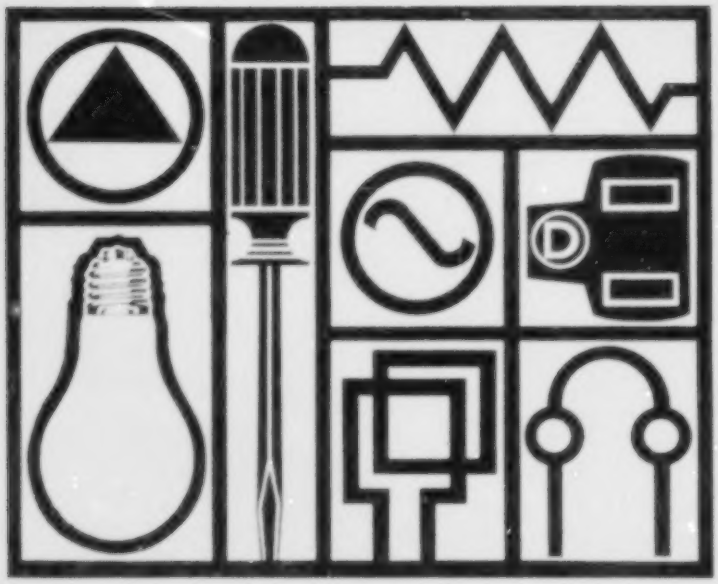
CRITERIA FOR MODEL ELECTRICAL CLUSTER

The electrical cluster assessment instrument was developed by a teacher assistance team consisting of high school and community college electronics teachers in Oregon. They were invited by the Oregon Department of Education to develop criteria for model electrical clusters. These criteria are listed below:

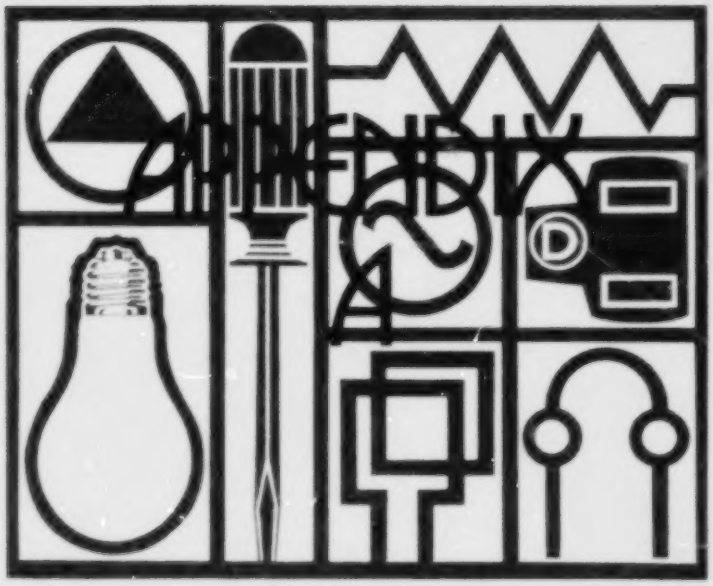
Facilities and Equipment
Finances
Work Experience
Advisory Committee
Curriculum
In-service
Interdisciplinary Studies
Youth Organization
Placement and Follow-up
Staff
Individualized Instruction
Articulation
Long-range Planning
Safety

Assessment is both internal (school staff) and external (Oregon Department of Education). Each area is rated on a scale of 0-100 points, with 80-100 being in the Model Program range.

The electrical cluster assessment manual is a companion publication and can be obtained from the electrical specialist at the Oregon Department of Education.



APPENDIXES



CERTIFICATE OF COMPETENCY

No Exposure	Introduced to Concept	Minimum Skills in Concept	Proficient in Concept	BASIC CONCEPTS AND RELATED SKILLS
				Can calculate electrical circuit characteristics involving:
				---- Ohm's Law
				---- Watt's Law
				---- series resistive circuits
				---- parallel resistive circuits
				---- Kirchoff's Law
				---- sine wave values
				---- transformers
				---- inductance
				---- capacitance
				---- resonance
				---- inductive reactance
				---- capacitive reactance

				Can demonstrate knowledge of:
				---- electron theory
				---- voltage, current & resistance
				---- conductors, insulators, semiconductors
				---- magnets
				---- magnetic fields
				---- AC terminology
				---- voltaic cells
				---- primary and storage cells
				---- DC generators
				---- alternators
				---- DC motors
				---- AC motors
				---- synchro & servo systems
				---- multiple contact switches
				---- motor controls
				---- diodes
				---- transistors
				---- tubes
				---- amplification
				---- oscillators

				Can properly use:
				---- scientific notation
				---- slide rule for multiplication & division
				---- slide rule for finding squares & square roots
				---- slide rule for finding reciprocals
				---- electronic calculator

CERTIFICATE of COMPETENCY

ELECTRICITY–ELECTRONICS VOCATIONAL SKILLS RECORD

OREGON DEPARTMENT
OF EDUCATION
942 LANCASTER DRIVE, NE
SALEM, OREGON 97310

John W. Havery, Specialist
Division of Career & Vocational Education

STUDENT _____

SCHOOL YEAR(S) _____ _____

No Exposure	Introduced to Concept	Minimum Skills in Concept	Proficient in Concept	SYMBOLS, COMMUNICATIONS and TECHNICAL LITERATURE
				Can properly:
				.... keep time, material, cost records
				.... make and use schematic diagrams & layouts
				.... interpret basic symbols
				.... use color codes
				.... use parts catalogs for orderings
				.... use equipment instruction manuals
				.... read a graph
				.... plot rectangular coordinate graphs
				.... plot logarithmic and polar graphs
				.... work well with others
				.... write reports clearly and legibly
				.... follow blueprints
				.... interpret nameplate data
				.... make and use block diagrams
				.... identify electrical materials
				.... identify electronic components
				.... _____
				.... _____
				.... _____
				TEST EQUIPMENT
				Can properly:
				.... read meters
				.... convert meter functions
				.... use volt-ohm-ammeter
				.... use power supplies
				.... use vacuum tube voltmeters
				.... use AF & RF signal generators
				.... use general purpose oscilloscopes
				.... use digital voltmeters
				.... test tubes
				.... test transistors
				.... test capacitors
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INSTRUCTOR _____

INSTRUCTOR _____

No Exposure	Introduced to Concept	Minimum Skills in Concept	Proficient in Concept	ELECTRO-MECHANICAL CONSTRUCTION, INSTALLATION MAINTENANCE and REPAIR
				Demonstrates proper skills in:
				.... electrical-mechanical safety
				.... soldering
				.... conventional drill press operation
				.... use of special electrical tools
				.... wire selection for respective applications
				.... fundamentals of trouble shooting
				.... electrical trouble shooting
				.... mechanical trouble shooting
				.... refrigeration trouble shooting
				.... refrigeration mechanical repair
				.... heating system analysis
				.... chassis construction
				.... electronic wiring
				.... component mounting
				.... printed circuit etching & design
				.... installing electrical cable and conduit
				.... making electrical splices and connections
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Criteria which determine an acceptable level are too detailed to be included in this report. If you are interested in this detail contact the school directly.

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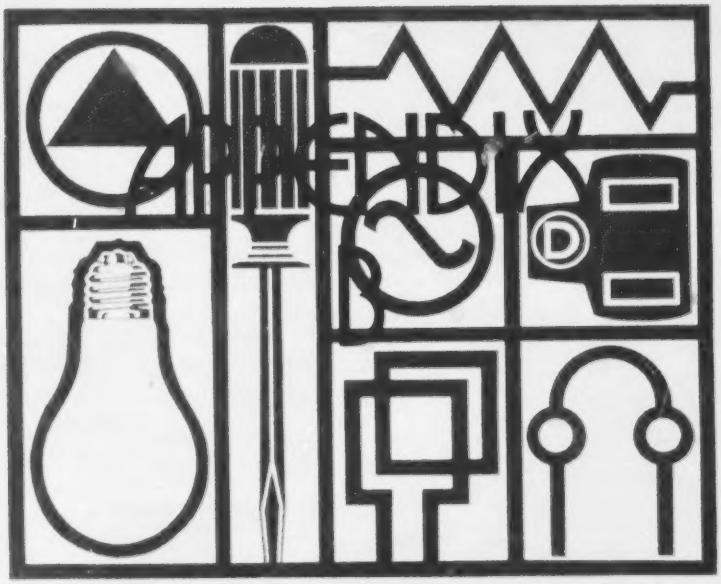

JOB DESCRIPTIONS FROM THE DICTIONARY OF OCCUPATIONAL TITLES

D.O.T. Code 827781

JOB TITLE: Electrical-Appliance Serviceman

ELECTRICAL-APPLIANCE SERVICEMAN (Any industry) This person installs, services and repairs stoves, refrigerators, dishwashing machines and other electrical household appliances. He/she connects appliance to power source and test meters, such as wattmeter, ammeter and voltmeter. He/she traces electrical circuits, locates shorts and grounds, disassembles appliance, examines mechanical and electrical parts and repairs and adjusts appliance motor. He/she replaces worn or defective parts and reassembles, adjusts and lubricates.

D.O.T. Code 824281

JOB TITLE: Electrician

ELECTRICIAN (Any industry) This person plans layout, installs and repairs wiring, electrical fixtures and control equipment. He/she plans new or modified installments and measures, cuts, bends, threads, installs electrical conduit. He/she splices wires by twisting or soldering wires together and applies tape and terminal caps. He/she connects wiring to lighting fixtures and power equipment and installs control panels and switches. He/she tests continuity of circuit, using ohmmeter, battery and oscilloscope.

D.O.T. Code 003181

JOB TITLE: Electronic Technician

ELECTRONIC TECHNICIAN (Profess and Kin) This person applies electronic theory, electrical testing procedures, engineering mathematics and physics to lay out, build, test, troubleshoot, repair, modify electronic equipment, such as computer and machine-tool numerical controls. He/she assembles experimental circuitry (breadboard) and sets up standard test apparatus or contrives test equipment and circuitry. He/she adjusts, calibrates, aligns, modifies circuitry and components and writes technical reports.

D.O.T. Code 720281

JOB TITLE: Television Service & Repairman

TELEVISION SERVICE AND REPAIRMAN (Any industry) This person repairs and adjusts radios and television receivers, using hand tools and electronic testing instruments. He/she tunes receiver, observes audio and video characteristics to locate source of trouble. He/she adjusts controls to obtain density, linearity, focus and size of picture. He/she tests voltages and resistances of circuits and tests and changes tubes. He/she solders loose connections, repairs or replaces defective parts and repairs radios and other audio equipment.

D.O.T. Code 726781

JOB TITLE: Electronics Assembler

ELECTRONICS ASSEMBLER (Electronics) This person assembles electronic equipment, such as computers, movie sound recorders, radar and sonar, telemetering systems, through the use of test equipment, hand tools, power tools, and by following blueprints, diagrams and manufacturing standards. He/she connects wires, resistors, diodes, rectifiers to terminals, using soldering iron or spot welder. He/she tests circuits for opens and shorts using continuity tester.

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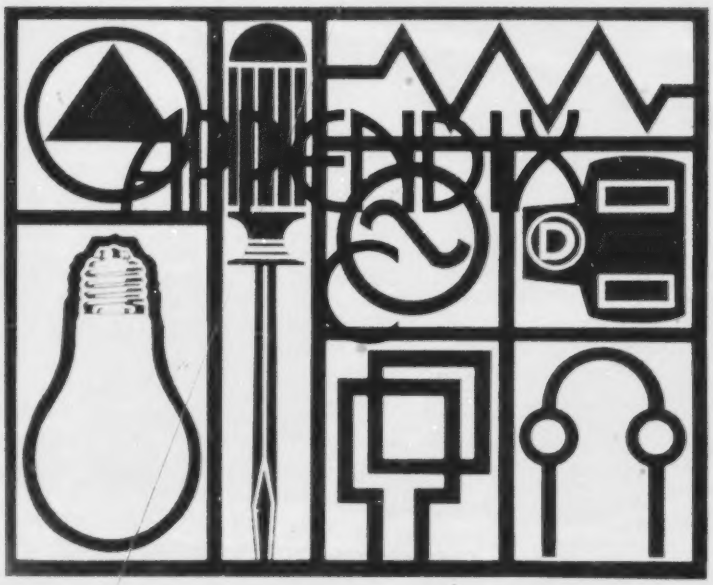

MEDIA AND MATERIALS

An Accident Prevention Program for School Shops and Laboratories is an excellent source of safety ideas. The report is too long to be included in this guide, but it may be ordered from the U.S. Department of Health, Education and Welfare, Office of Education.

FILMS FOR
EXPLORING ELECTRICITY-ELECTRONICS

1. *AB Circuit Breakers* - 10 min., b/w. (Westinghouse, free loan.)
2. *A Missile Named Mac* - 7 min., color. (Local Telephone Office, free loan.)
3. *Amperes, Volts, and Ohms* - 10 min., b/w. (Teaching Aids, Incorporated, rental $2.50.)
4. *"A" is for Atom* - 15 min., color. (Atomic Energy Commission, free loan.)
5. *Atom and the Kilowatt* - 12 min., color. (Univ. of Mich., $1.00 rental.)
6. *Basic Electricity* - 20 min., color. (Almanac, free loan.)
7. *Battery Electricity* - 11 min., b/w. (Univ. of Ill., $2.15 rental.)
8. *The Bell Solar Battery* - 13 min., color. (Local Telephone Office, free loan.)
9. *Beyond All Barriers* - 27 min., color. (Local Telephone Office, free loan.)
10. *Charging Storage Batteries* - 15 min., b/w.(Teaching Aids, Incorporated, $3.00 rental.)
11. *Conductors and Semiconductors* - 13 min., color. (Local Telephone Office, free loan.)
12. *Current and Electromotive Force* - 11 min., b/w. (Navy, free loan.)
13. *Electric Circuits* - 11 min., b/w. (Univ. of Ill., $2.15 rental.)
14. *Electric Circuit Faults* - 19 min., b/w. (National Educational Television, $2.90 rental.)
15. *Electricity For Beginners* - 10 min., color. (National Educational Television, $3.90 rental.)
16. *Electricity: How It Is Generated* - 13 min., color. (National Educational Television, $3.90 rental.)
17. *Electricity: How To Make A Circuit* - 11 min., color. (Univ. of Mich., $2.25 rental.)
18. *Electricity: Measurement* - 12 min., color. (Ind. Univ., $3.40 rental.)
19. *Electricity: Static Electricity* - 11 min., color. (Ind. Univ., $3.40 rental.)
20. *Electrodynamics* - 11 min., b/w. (Teaching Aids, Incorporated, $2.50 rental.)
21. *Electrostatics* - 11 min., b/w. (Teaching Aids, Incorporated, $2.50 rental.)
22. *Electromagnets: How They Work* - 10 min., color. (National Educational Television, $3.50 rental.)
23. *Heat and Light From Electricity* - 17 min., b/w. (National Educational Television, $1.65 rental.)
24. *How Magnets Produce Electricity* - 4 min., b/w. (Navy, free loan.)
25. *How To Produce Electric Current With Magnets* - 10 min., color. (National Educational Television, $2.15 rental.)
26. *How Transformers Work* - 15 min., b/w. (Michigan State University, $1.00 rental.)
27. *Inductance* - 20 min., color. (Allis-Chalmers, free loan.)
28. *Infrared* - 15 min., color. (Aerojet, free loan.)
29. *Magnetic Effects of Electricity* - 14 min., b/w. (Univ. of Ill., $1.65 rental.)
30. *Magnetism* - 11 min., color. (Coronet, $1.75 rental.)
31. *Measurement of Electricity* - 12 min., color. (Coronet, $2.00 rental.)
32. *Mechanical Generation of Energy* - 15 min., color. (Michigan State University, $1.00 rental.)
33. *Mr. Bell* - 32 min., color. (Local Telephone Office, free loan.)

34. *Ohm's Law* - 19 min., b/w. (Teaching Aids, Incorporated, $3.00 rental.)
35. *Plane Talk* - 20 min., color. (Local Telephone Office, free loan.)
36. *Principles of Electricity* - 20 min., color. (General Electric, $1.00 rental.)
37. *Principle of the Generator* - 10 min., b/w. (National Educational Television, $2.15 rental.)
38 *Project Telstar* - 14 min., color. (Local Telephone Office, free loan.)
39. *Receiving Radio Messages* - 11 min., b/w. (Michigan State University, $2.25 rental.)
40. *Series and Parallel Circuits* - 10 min., b/w. (Teaching Aids, Incorporated, $2.50 rental.)
41. *Sources of Electricty* - 10 min., b/w. (Univ. of Ill., $2.15 rental.)
42. *Using Ohm's Law To Understand Circuits* - 15 min., b/w. (Michigan State University, $1.00 rental.)
43. *Watts, Watthours, and Watthour Meters* - 15 min., b/w. (Michigan State University, $1.00 rental.)
44. *Electrical Workers* - Purdue University. Write.
45. *Television Workers* - Purdue University. Write.
46. *Telephone Linemen* - Purdue University. Write.

FILM DISTRIBUTOR ADDRESSES

Allis-Chalmers Mfg. Co., Milwaukee, Wisconsin.

Aeroject General Corporation, Corporate Public Relations, 900 E. Flair Ave., El Monte, California.

AEC - Atomic Energy Commission. Write regional office, if known. If unknown, write Audio-Visual Branch, Division of Public Information, U.S. Atomic Energy Commission, Washington, D.C.

Coronet Films, Coronet Building, Chicago, Illinois.

GE - General Electric Company, 1 River Road, Schenectady, New York.

LTO - Local Telephone Office. Allow at least three months before showing date, preferably a year.

MSU - Michigan State University, Instructional Media Center, East Lansing, Michigan.

Navy, 9th Naval District Building, Great Lakes, Illinois.

NET - NET Film Service, Audiovisual Center, Indiana University, Bloomington, Indiana.

Purdue University, Audiovisual Center, West Lafayette, Indiana.

TAI - Teaching Aids, Inc., P.O. Box 3527, Long Beach, California.

University of Illinois, Visual Aids Service, Division of University Extension, Champaign, Illinois.

University of Michigan, Audiovisual Center, 416 Fourth Street, Ann Arbor, Michigan.

Westinghouse Electric Corp., Film Library, Pittsburg, Pennsylvania.

FILMS FOR
BASIC ELECTRICITY-ELECTRONICS

1. *Introduction to Electricity* - 11 min., Arkansas State University.
2. *Electrons At Work* - 14 min., Missouri University.
3. *Elements of Electrical Circuits* - 10 min., Missouri University.
4. *Wire Sizes and Voltage Drop* - 11 min., Illinois University.
5. *Ohm's Law* - 6 min., Illinois University.
6. *Primary Cell* - 10 min., Illinois University.
7. *Story of the Modern Storage Battery* - 27 min., Bureau of Mines.
8. *Bell Solar Battery* - 15 min., Bell Telephone System.
9. *Magnetism* - 11 min., Iowa University.
10. *Ferromagnetic Domains* - 22 min., Bell Telephone System.
11. *Circuit Testing with Meters and Multimeters* - 37 min., Illinois University.
12. *The Oscilloscope, What it is and What it Does* - 9 min., Tektronix, Inc.
13. *Charles Proteus Steinmetz - The Man Who Made Lightning* - 15 min., Illinois University.
14. *Inductance* - 34 min., Teaching Aids, Inc.
15. *How Transformers Work* - 15 min., Michigan State University.
16. *Capacitance* - 31 min., University of Michigan.
17. *RCL: Resistance and Capacitance* - 34 min., Teaching Aids, Inc.
18. *Fundamentals of AC and DC Generators* - 19 min., Illinois University.
19. *Making Electricity* - 10 min., Missouri University.
20. *Electric Decision* - 18 min., Association Films.
21. *The Electrician* - 10 min., Missouri University.
22. *Electrical Wiring with Aluminum* - 15 min., Association Films, Inc.
23. *The Transistor* - 10 min., Bell Telephone System.
24. *Vacuum Tubes* - 11 min., Missouri University.
25. *Principles of the Transistor* - 21 min., Illinois University.
26. *Electronics* - 13 min., Missouri University.
27. *World of Semiconductors* - 44 min., Illinois University.
28. *Your Voice and the Telephone* - 7 min., Bell Telephone System.
29. *Sounds Familiar* - 24 min., Bell Telephone System.
30. *Radio Waves* - 27 min., Iowa University.
31. *Receiving Radio Messages* - 11 min., Iowa University.
32. *Radio Receivers, Principles, and Typical Circuits* - 17 min., Illinois University.
33. *Television, How It Works* - 11 min., Missouri University.
34. *Quest* - 13.5 min., Association Films, Inc.

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16MM FILM DISTRIBUTORS' ADDRESSES

University of Missouri, Extension Division, Audiovisual and Communication Service, 119 Whitten Hall, Columbia, Missouri.

University of Illinois, Visual Aids Service, Division of University Extension, Champaign, Illinois.

Bell Telephone Company, Nearest Local Bell Telephone Company Business Office.

Tektronix Incorporated, Film Library, P.O. Box 500, Beaverton, Oregon.

Teaching Aids, Inc., P.O. Box 3527, Long Beach, California.

Michigan State University, Instructional Media Center, East Lansing, Michigan.

University of Michigan, Audiovisual Center, 416 Fourth Street, Ann Arbor, Michigan.

Arkansas State University, Audiovisual Center, State College, Arkansas.

United State Department of the Interior, Motion Pictures, 4800 Forbes Avenue, Pittsburgh, Pennsylvania.

University of Iowa, Audiovisual Center, Iowa City, Iowa.

Association-Sterling Films, 600 Madison Avenue, New York, New York.

TRANSPARENCIES

Transparencies Pac Set
McKnight and McKnight Publishing Company
Bloomington, Illinois

Electricity and Basic Electronics
D.C.A. Educational Products, Inc.
4865 Stenton Avenue
Philadelphia, Pennsylvania

Basic Electronics Transparencies
Educational Technologies, Inc.
3546 Dakota Avenue
Minneapolis, Minnesota

Battery Operation, Construction, and Testing

Fundamentals of Electricity

Alternators Principles of Operations
Ford Motor Company
Service Training
Dearborn, Michigan

Electricity one—seven
Hayden Book Company, Inc., New York
116 W. 14th Street
New York, N.Y.

FILMSTRIPS

Electricity Series No. 11330
Experimenting with Static Electricity
Electricity by Chemical Reaction
Electricity in Circuits
Electricity and Heat
Electricity and Magnetism
Building an Electric Generator
Transformers

Encyclopaedia Britannica Educational Corporation
425 North Michigan Avenue, Chicago, Illinois

Electricity and Magnetism Set A-6
588 *Safe and Sure with Electricity*
561 *How Batteries Work*
577 *How AC and DC Motors Work*
602 *Modern Theories of Magnetism*
605 *Electric Fields*
621 *Alternating Current Circuits*
640 *Electric Instruments*

Popular Science Publishing Company, Inc.
Audio-Visual Division
1355 Lexington Avenue
New York, New York

Electricity Set No. 3 170050
How Television Works
Distributing Electric Power
Putting Electrolysis to Work
What is Electronics
What is Magnetism

McGraw-Hill Film Division of McGraw-Hill Book Company
300 West 42nd Street, New York, New York

Filmstrips with Records
The Cranking Circuit and How it Works
20,000 Volts Under the Hood
Delcotron Generator and a New Charging Circuit
Regulation and the Charging Circuit

Delco Remy Division G. M. C.

SINGLE CONCEPT FILM LOOPS

Electrical House Wiring Film Loop Set

1. *The third wire can save your life.*
2. *Rewiring a lamp.*
3. *Wiring an attachment plug.*
4. *Troubleshooting a bell circuit.*
5. *Outlet box installation.*
6. *Wiring a box with armored cable.*
7. *Connecting wires in an outlet box.*
8. *Installing a convenience outlet.*
9. *Toggle switch installation.*

Scott Education Division
Holyoke, Massachusetts

FILMS FOR COMMUNICATIONS ELECTRONICS

1. *Vacuum Tubes* - 11 min., Missouri University.
2. *Electronics* - 13 min., Missouri University.
3. *Charles Protens Steinmetz - The Man Who Made Lightning* - 15 min., Illinois University.
4. *World of Semi-conductors* - 44 min., Illinois University.
5. *Radio Waves* - 27 min., Iowa University.
6. *Receiving Radio Messages* - 11 min., Iowa University.
7. *The Oscilloscope, What It is and What It Does* - 9 min., Free films.
8. *The Oscilloscope Draws a Graph* - 20 min., Free films.
9. *Cathode-Ray Tube, Window to Electronics* - 35 min., Free films.
10. *Electricity: Principles and Safety* - 11 min., University of Arizona.
11. *ABC's of Hand Tools* - 18 min., Arizona State University.
12. *Your Future in Electronics* - 24 min., RCA Institute.
13. *The Electronic Technician* - Modern Talking Pictures Service.
14. *Measurement of Electricity* - 22 min., University of Arizona.
15. *Circuit Testing* - 33 min., Army or University of Iowa.
16. *The Diode: Principles and Applications* - 17 min., University of Illinois.
17. *The Principle of the Gas Filled Tube* - 15 min., University of Illinois.
18. *Vacuum Tubes* - 30 min., Brigham Young University.
19. *Inductance* - 33 min., University of Illinois.
20. *Induced Electric Current* - 30 min., Brigham Young University.
21. *Capacitance* - 30 min., University of Illinois.
22. *RCL: Resistance Capacitance* - 30 min., University of Illinois.
23. *Vectors* - 11 min., University of Illinois.
24. *The Triode: Amplification* - 14 min., University of Illinois.
25. *Cathode-Ray Tube* - 25 min., Tektronix, Inc.
26. *Radio Waves* - 27 min., Arizona State University.
27. *Oscillators, Amplifiers, and Radios* - 30 min., University of Illinois.
28. *Genesis of the Transistor* - 20 min., Bell Telephone Company.
29. *Principles of Transistors* - 22 min., University of Illinois.
30. *The Television System* - McGraw-Hill.
31. *Television Receivers* - McGraw-Hill.
32. *Practical TV Alignment* - McGraw-Hill.
33. *Television - How It Works* - 11 min., ASU (Coronet).

34. *Basic Principles of FM* - 31 min., U.S. Army, Ft. Hauchuca.
35. *Oscillators* - 28 min., U.X.N./United World Films.
36. *Radio Transmitter Principles* - 17 min., University of Illinois.
37. *Electromagnetic Waves* - 17 min., ASU (Encyclopaedia Britannica Films).
38. *Effects of the Ionosphere on Radio Wave Propagation* - 29 min., United States Army, Ft. Huachuca.
39. *Mirror in the Sky* - 22 min., University of Colorado.
40. *Transmission Lines* - 23 min., Tektronix, Incorporated.
41. *Standing Waves on Transmission Lines* - 22 min., University of Illinois.

TRANSPARENCIES

Semi-conductor Transparencies:
Educational Technologies, Inc.
3546 Dakota Avenue
Minneapolis, Minnesota

Transparencies Pac Set:
McKnight and McKnight Publishing Company
Bloomington, Illinois

Electricity and Basic Electronics:
D.C.A. Educational Products, Inc.
4865 Stenton Avenue
Philadelphia, Pennsylvania

Transparencies Electricity Electronics: Series 601-602-603-604
Lab Volt Educational Systems
Buck Engineering Company, Inc.
Farmingdale, New Jersey

Transparencies Electricity Electronics:
Brodhead Garrett
4560 East 71st Street
Cleveland, Ohio

SUPER 8 SINGLE CONCEPT FILMS

1. 100 Series - *Tubes and Tube Circuits.*

   300 Series - *Transistors and Transistor Circuits.*

   500 Series - *Alternating Current Theory.*

   Animated Electronic Films
   P.O. Box 2036, Eads Station
   Arlington, Virginia

2. *Television Symptom Diagnosis*
   Thirty-three single concept film loops.

   Howard W. Sams & Company, Inc.
   4300 West 62nd Street
   Indianapolis, Indiana

16MM FILM DISTRIBUTORS' ADDRESSES

University of Missouri, Extension Division, Audiovisual and Communication Service, 119 Whitten Hall, Columbia, Missouri.

University of Illinois, Visual Aids Service, Division of University Extension, Champaign, Illinois.

Tektronix, Incorporated, Film Library, P.O. Box 500, Beaverton, Oregon.

Bell Telephone Company, Nearest Local Bell Telephone Company Business Office.

Coronet Films, Coronet Building, Chicago, Illinois.

Encyclopaedia Britannica, Educational Corporation, 425 North Michigan Avenue, Chicago, Illinois.

University of Iowa, Audiovisual Center, Iowa City, Iowa.

University of Arizona, Audiovisual Center, Tucson, Arizona.

Arizona State University, Audiovisual Center, Tempe, Arizona.

Radio Corporation of America Institute, Education Programs, Rt. 38 East Haddonfield Road, Building 204-1, Cherry Hill, New Jersey.

Modern Talking Pictures Service, 3718 Broadway, Kansas City, Missouri.

Brigham Young University, Audiovisual Center, Provo, Utah.

McGraw-Hill Films, 828 Custer Avenue, Evanston, Illinois.

United World Films, 221 Park Avenue South, New York, New York.

University of Colorado, Audiovisual Center, Boulder, Colorado.

Public Information Officer, United States Army; Ft. Huachuca, Arizona.

FILMS, TRANSPARENCIES, AND SUPER 8 SINGLE CONCEPT FILMS FOR INDUSTRIAL ELECTRONICS

1. *Electric Power Generation in Space* - (HQ 155) 26½ min., color, 1967 (NASA).
2. *Safety Precautions for Electronic Personnel* - 20 min., University of Illinois.
3. *Proper Handling of Cathode-Ray Tubes* - 20 min., color, 1962 (TKTR).
4. *Automatic Machines* - 20 min., Massachusetts Institute of Technology.
5. *Automation* - 30 min., b/w (USOE).
6. *IBM Control Systems at Work* - 5 min., b/w, 1962 (IBM).
7. *Radar and T.V.* - Encyclopaedia Britannica Films.
8. *Coaxial and Microwave Miracles* - 10 min., University of Colorado.
9. *Scatter Radar* - 22½ min., color, 1963 (NBOS).
10. *Thinking Machines* - 20 min., color, University of Missouri.
11. *Memory Devices* - 29 min., University of Arizona.
12. *Electronic Computers and Applied Mathematics* - 23 min., University of Colorado.
13. *Electric Propulsion* - (HQ 96) 24 min., color, 1965 (NASA).
14. *Power for the Moonship* - (HQK-SR4) 28½ min., b/w, 1966 (AEC).
15. *Radioisotope Applications in Industry* - (91964) 26½ min., b/w (AEC).
16. *Nuclear Power for Space-Snap 9A* - 12 min., b/w, 1963 (AEC).
17. *The Atom in Industry* - 12½ min., b/w, 1954 (AEC).
18. *By the Numbers* - 16 min., color, 1962 (IBM).
19. *Modern Heat Treating Methods* - 15 min., color, 1965 (LNCO).
20. *Varidyne AC Controlled Speed Systems* - 22 min., color, 1962 (USEM).
21. *The Story of a Value* - 30 min., color, 1957 (RMCO).
22. *Prescan - An/SPS42* - 7 min., color (HUAC).
23. *The Control Revolution* - 29 min., b/w, $5.40 (NET).
24. *Automation in Air Traffic Control* - 10 min., color, $1.15 (NET).
25. *Transistors: Switching* - 14 min., b/w, 1959, free, Navy.
26. *Transistors.* Part I: Introduction - b/w, 1961, free, Navy.
27. *Transistors: Servicing Techniques* - b/w, 1960, free, Navy.
28. *Transistors: Triode Fundamentals* - b/w, 1957, free, Navy.
29. *Genesis of the Transistor* - 15 min., color, 1965 (BELL).
30. *The Information Machine* - 10 min., color, 1958 (IBM).
31. *Instrument Assembly and Production Flow* - 27 min., color, 1961 (TKTR).
32. *Machines That Think* - 29 min., 1962 (AEC).

33. *The New Giant* - 15 min., color (HUAC).
34. *Pax Atomis: Snap-7* - 25 min., color, 1965 (AEC).
35. *Snapshot* - 30 min., color, 1965 (AEC).
36. *Tektronic and the World of Measurement* - 23 min., color, 1966 (TKTR).
37. *Solving the Unbalanced Bridge* - 17 min., 1964 (TKTR).
38. *Oscilloscopes and Transducers* - 15 min., color, 1968 (TKTR).
39. *Circuit Boards - Design and Manufacturing* - 30 min., color, 1967 (TKTR).

16MM FILM DISTRIBUTORS' ADDRESSES

T.A.I.	Teaching Aids, Incorporated, P.O. Box 5527, Long Beach, California
NAVY	9th Naval District, Building 1, Great Lakes, Illinois 60085
NET	NET Film Service, Audiovisual Center, Indiana University, Bloomington, Indiana
MU	University of Missouri, Extension Division, Audiovisual and Communication Service, 119 Whitten Hall, Columbia, Missouri 65201
USOE	U.S. Office of Education, Department of Health, Education, and Welfare, 330 Independence Avenue SW, Washington, D.C. 20201
LNCO	Leads & Northrup Co., Rockland and Stenton Avenue, Philadelphia, Pennsylvania 19144
USEM	U.S. Electrical Motors, Division of Emerson Electric Company, Old Gate Lane, Milford, Connecticut 06460
RMCO	Rockwell Manufacturing Company, Power Tool Division, Rockwell Building, Pittsburg, Pennsylvania 15208
I.B.M.	International Business Machines, 301 East Armour, Kansas City, Missouri
ADCP	Admiral Corporation, 3800 West Cortland Street, Chicago, Illinois 60647
BELL	Nearest Local Bell Telephone Company Business Office
HUAC	Hughes Aircraft Corporation, 500 Superior Avenue, Newport Beach, California 92660
TKTR	Tektronix, Incorporated, Film Library, P.O. Box 500, Beaverton, Oregon 97005
AEC	United States Atomic Energy Commission, P.O. Box 62, Oak Ridge, Tennessee 37830
NBOS	National Bureau of Standards, United States Department of Commerce, Clearing House, Springfield, Virginia 22151
NASA	George C. Marshall, Space Flight Center, Public Affairs Office, Huntsville, Alabama 35812
AISI	American Iron & Steel Institute, Teaching Aids Distribution Center, Bedford Hills, New York 10507
GM-DR	Delco-Remy Division, General Motors Corporation, Technical Literature Section, Anderson, Indiana 46011
NTEA	Norelco Training and Educational Aids, North American Phillips Company, Incorporated, Professional Products Division, 100 East 42nd Street, New York, New York 10017
EBEC	Encyclopaedia Britannica, Educational Corporation, 425 North Michigan Avenue, Chicago, Illinois 60611
AEFC	Animated Electronic Film Co., P.O. Box 2036 Eads Station, Arlington, Virginia 22202

35MM FILMSTRIPS

Electric Propulsion - 24 min., color, 1965 (NASA).

The Optical Comparator Story - 35 min., color, 1962 (Jones & Lawson-A Textrons Co.)

Science, Technology and Society - 68 frames, color, 1965. American Iron & Steel Institute (will supply one print to any school system).

Space Navigation - 69 frames, color, 1967. Emphasis on use of computers in space flights. (NASA)

Regulation and the Charging Circuits - 12 min., color (Delco-Remy Division).

The Thyratron - 27 frames, color, $8.50 (NORELCO).

The Ignitron - 24 frames, color, $8.50 (NORELCO).

Photo-Electric Emission - 31 frames, color, $8.50 (NORELCO).

Cold Cathode Tubes - 28 frames, color, $8.50 (Switching-Relay Tube-Counter and Indicator Tubes) (NORELCO).

Industrial Electronics Series - GE, SD.

1. *Thy-Mo-Trol*
2. *Photoelectric Relay Systems.*

FILM DIRECTORIES

Guide to Government - Loan Film (16mm), 1969-70, Serina Press, 70 Kennedy Street, Alexandria, Virginia 22305.

Guide to Military - Loan Film (16mm), Serina Press, 70 Kennedy Street, Alexandria, Virginia 22305.

Index to 16mm Educational Films (1967), McGraw-Hill Book Company, New York, New York 10023

Educators Guide to Free Films (1967), Educators Progressive Service, Randolph, Wisconsin 53956.

Film Catalog, University of Missouri - Columbia, Extension Division, Audiovisual and Communication Service, 119 Whitten Hall, Columbia, Missouri 65201.

SUPER 8MM FILM LOOPS

System of Twos S(80085) - Color $17.60

Sine Function S(80102) - Color $17.60

Vectors No. 1 S(80881) - Color $22.00

What does 10 mean? S(80176) - Color $22.00

Encyclopaedia Britannica
Educational Corporation
425 N. Michigan Avenue
Chicago, Illinois 60611

Transistorized Multivibrator No. 320 - Color $17.00 (AEFC)

Series LCR Circuits - Color $17.00 (AEFC)

Series LCR Circuits-part II - Color $17.00

Transistor Characteristic Curves - Color $17.00

Audio Voltage Amplifier (with NPN Transistor) - Color $17.00

Animated Electronic Film Company
P.O. Box 2036, Eads Station
Arlington, Virginia 22202

INDUSTRIAL ELECTRONICS PROJECT TEXTS

Boschen, Lee. *Computer Circuit Projects You Can Build*, (No. BOC-1). Indianapolis: Howard Sams Publishing Company.

RCA, *Solid State To BB4 Circuits Manual,* RCA Electronic Components, Harrison, New Jersey, 1967.

RCA, *Experimenter's Manual,* Silicon Controlled Rectifier, RCA Electronic Components and Devices. Harrison, New Jersey, 1967.

ELECTRICITY - ELECTRONICS
BIBLIOGRAPHY

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Arnold, Joseph P. & Schank, K. L. *Exploratory Electricity.* 1964. McKnight & McKnight.

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ARRL Staff. *Radio Amateur Handbook.* American Radio Relay League.

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Buchsbaum, Walter H. *Fundamentals of Television.* 1964. John F. Rider.

Buckwalter. *Having Fun With Transistors.* 1963. Buckwalter & Sams.

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Carooll, John. *Careers and Opportunities in Electronics.* 1966. Dutton.

Collings, M. D. *Projects in Electricity.* 1958. McKnight & McKnight.

Cook, S. R. *Electrical Things Boys Like To Make.* 1954. Bruce.

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Cornetet & Cornetet. *Principles of Electricity & Basic Electronics* (3rd Edition). 1963. McKnight & McKnight.

Croft. *American Electrician's Handbook* (8th Edition). 1961. McGraw-Hill.

Crowhurst. *Basic Audio Courses.* 1964. Rider.

Dawes, Chester. *Industrial Electricity.* 1956. McGraw-Hill.

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Delpit & Johnson. *Electronics in Action.* 1966. Charles A. Bennett.

Duarte & Duarte. *Electronics Assembly Methods.* 1964. McGraw-Hill.

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Journal of the British I.R.E. *Solar Cells for Communications Satellites in the Van Allen Belt.*

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Ford & Steinberg. *Electricity & Electronics.* (3rd Edition). American Technical Society.

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Gerrish, Howard H. *Transistors Electronics.* 1969. Goodheart-Willcox.

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Graham, Kennard. *National Electrical Code and Blueprint Reading.* 1961. American Technical Society.

Graham, Kennard. *Understanding and Servicing Fractional Horsepower Motors.* 1961. American Technical Society.

Grob. *Basic Electronics* (2nd Edition). 1965. McGraw-Hill.

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Henry. *Principles of Radio.* McGraw-Hill.

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